ZOLL PD 1200
Pacemaker / Defibrillator
Service Manual

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Revision B

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TABLE OF CONTENTS

DESCRIPTION SECTION

I. General Information

Table of Contents I-3
Index by Topic I-7
Safety Notices I-11
How to Use This Manual I-12
Service Policy I-14

II. Operation

I. General Information 1
II. Operating Controls and Indicators 11
III. Emergency Defibrillation Procedure 15
IV. Synchronized Cardioversion 19
V. Noninvasive Temporary Pacing (NTP) 23
VI. ECG Monitoring 29
VII. Operation with Multi-Function Electrodes 33
VIII. Operational Checks and Procedures 39
IX. Extended Diagnostics 47

III. Checkout Procedures

Recommended Daily Checkout Procedure III-3
1. Visual Inspections III-4
2. Power-up Sequence Test III-5
3. Pacer Accuracy III-6
4. Delivered Energy and Discharge Buttons Check III-7
5. Recorder Operation Check III-8
6. Maintenance After Use III-9
7. Storage Check III-9
Recommended Six-Month Checkout Procedure III-11
1. Initialize Test III-13
2. High Pot Test III-14
3. Leakage Test III-15
4. Charger and Power Supply Tests III-17
5. Extended Diagnostics Mode Tests III-19
6. ECG Tests III-20
7. Pacer Tests III-22

8. Defibrillator Tests III-26
9. MFE Tests III-30
10. Real Time Clock Check III-31
Six-Month Checkout Procedure Data Sheet III-33

IV. Basic Maintenance

1. Setting Time and Date IV-2
2. Changing Paper IV-3
3. Clearing a Recorder Paper Jam IV-4
4. Caring for the Battery IV-5
5. Changing the Battery Pack IV-5
6. Cleaning the PD 1200 ..... IV-6

V. Troubleshooting Guides

Operational Troubleshooting Guide V-3
1. Monitor V-4
2. Recorder V-6
3. Noninvasive Pacing V-7
4. Pacing V-8
5. Defibrillator V-9
Technical Troubleshooting Guide V-11
1. Power-Up Sequence Test V-12
2. System Will Not Run V-13
3. No Response to User Controls V-14
4. Charger V-16
5. Power Supply V-18
6. Power Supply Control V-19
7. Display V-21
8. CPU V-23
9. Defibrillator V-25
10. Pacer V-28
11. ECG V-29
12. Recorder V-31
Error Codes V-32
Extended Diagnostics V-33

VI. Functional Descriptions

1. System VI-2
2. Charger VI-3
3. Power Supply VI-4
4. CPU VI-6

5. Defibrillator VI-9
6. Pacer VI-12
7. ECG VI-13
8. CRT VI-16

VII. Schematic Drawings

1. System VII-3
2. Charger VII-4
3. Power Supply VII-5
4. Power Supply Control VII-6
5. CPU VII-7
6. Defibrillator VII-12
7. Pacer VII-13
8. ECG VII-14
9. CRT VII-16
10. Input/Output VII-17
11. Primary Wiring Diagram VII-18

VIII. Component Layout Drawings

1. Charger VIII-3
2. Power Supply VIII-4
3. Power Supply Control VIII-5
4. CPU VIII-6
5. Defibrillator VIII-7
6. Pacer VIII-8
7. ECG VIII-9
8. CRT VIII-10
9. Input/Output VIII-11

IX. Disassembly Procedures

1. Removing the Battery IX-2
2. Removing the Recorder Module IX-3
3. Opening the PD 1200 ..... IX-4
4. Disconnecting Battery Power Internally IX-5
5. Removing the Pacer Board IX-7
6. Removing the CPU Board IX-9
7. Removing the ECG Board IX-11
8. Removing the Power Supply Module IX-12
9. Removing the Power Supply Control Board IX-13
10. Defibrillator Discharge Check IX-14
11. Removing the Defibrillator Module IX-15

12. Installing the Defibrillator Module IX-16
13. Removing the Charger Board IX-17
14. Removing the Front Bezel Switch Control Boards IX-18
15. Removing the CRT Board IX-20
16. Removing the CRT High Voltage Power Supply IX-21
17. Removing the Front Bezel IX-22
18. CRT Intensity Adjustment IX-23
19. Aligning the CRT IX-23

X. Replacement Parts

Field Replaceable Units X-2

Bill of Materials

Charger Printed Circuit Board Assembly X-3
CPU Printed Circuit Board Assembly X-5
CRT Printed Circuit Board Assembly X-9
Defibrillator Assembly X-13
ECG Printed Circuit Board Assembly X-17
Input/Output Printed Circuit Board Assembly X-22
Pacer Module Assembly X-23
Power Supply Printed Circuit Board Assembly X-25
Power Supply Control Printed Circuit Board Assembly X-28

INDEX BY TOPIC

Battery

Caring for the Battery IV-5
Changing the Battery Pack IV-5
Disconnecting Battery Power Internally IX-5
Removing the Battery IX-2
Storage Check III-9

Charger

Bill of Materials X-3
Component Layout Drawing VIII-3
Functional Description VI-4
Removing the Charger Board IX-17
Replacement Part Numbers X-2
Schematic VII-4
Six-Month Checkout Procedure III-17
Technical Troubleshooting Guide V-16

CPU

Bill of Materials X-5
Component Layout Drawing VIII-6
Functional Description VI-7
Removing the CPU Board IX-9
Replacement Part Numbers X-2
Schematic(s) VII-7
Technical Troubleshooting Guide V-23

CRT (Display)

Alignment Procedure IX-23
Bill of Materials X-9
Component Layout Drawing VIII-10
Functional Description VI-16
CRT Intensity Adjustment IX-23
Monitor Operational Troubleshooting Guide V-4
Removing the CRT Board IX-20
Removing the CRT High Voltage Power Supply IX-21
Replacement Part Numbers X-2
Schematic VII-16
Technical Troubleshooting Guide V-21

Defibrillator

Bill of Materials....X-13
Component Layout Drawing....VIII-7
Delivered Energy and Discharge Buttons Checkout Procedure....III-7
Functional Description....VI-9
Installing the Defibrillator Module....IX-16
Operational Troubleshooting Guide....V-9
Removing the Defibrillator Module....IX-15
Replacement Part Numbers....X-2
Schematic....VII-12
Six-Month Checkout Procedure....III-26
Technical Troubleshooting Guide....V-25

ECG

Bill of Materials....X-17
Component Layout Drawing....VIII-9
Functional Description....VI-13
Removing the ECG Board....IX-11
Replacement Part Numbers....X-2
Schematic(s)....VII-14
Six-Month Checkout Procedure....III-20
Technical Troubleshooting Guide....V-29

Input/Output

Bill of Materials....X-22
Component Layout Drawing....VIII-11
Replacement Part Numbers....X-2
Schematic....VII-17

Pacer

Bill of Materials....X-23
Component Layout Drawing....VIII-8
Functional Description....VI-12
Noninvasive Pacing Operational Troubleshooting Guide....V-7
Pacer Accuracy Checkout Procedure....III-6
Pacing Operational Troubleshooting Guide....V-8
Removing the Pacer Board....IX-7
Replacement Part Numbers....X-2
Schematic....VII-13
Six-Month Checkout Procedure....III-22
Technical Troubleshooting Guide....V-28

Power Supply

Bill of Materials X-25
Component Layout Drawing VIII-4
Functional Description VI-5
Removing the CRT High Voltage Power Supply IX-21
Removing the Power Supply Module IX-12
Replacement Part Numbers X-2
Schematic VII-5
Six-Month Checkout Procedure III-17
Technical Troubleshooting Guide *V-18*

Power Supply Control Board

Bill of Materials X-28
Component Layout Drawing VIII-5
Removing the Power Supply Control Board IX-13
Replacement Part Numbers X-2
Schematic VII-6
Technical Troubleshooting Guide V-19

Recorder

Changing Paper IV-3
Clearing a Recorder Paper Jam IV-4
Operational Troubleshooting Guide V-6
Recorder Operation Checkout Procedure III-7
Removing the Recorder Module IX-3
Replacement Part Numbers X-2
Setting Time and Date IV-2
Technical Troubleshooting Guide V-31

System

Cable Replacement Part Numbers X-2
Cleaning the PD 1200 ..... *IV-6*
Error Codes V-32
Extended Diagnostics V-33
Functional Description VI-2
Maintenance After Use III-8
Opening the Instrument IX-4
Power-up Sequence Checkout Procedure III-5
Power-Up Sequence Test V-12
Primary Wiring Diagram *VII-18*
Removing the Front Bezel IX-22
Removing the Front Bezel Switch Control Boards IX-18
Schematic VII-3

Setting Time and Date IV-2
Six-Month Extended Diagnostic Mode Checkout Procedure III-19
Storage Checks III-8
System Will Not Run V-13
Visual Inspections III-4

User Controls

Operational Troubleshooting Guide V-3
No Response to User Controls V-14
Replacement Part Numbers X-2

SAFETY NOTICES

WARNING

This device can generate up to 6000 volts with sufficient current to cause lethal shocks.

Please read carefully all the material contained herein.

THE PD 1200 SHOULD BE SERVICED BY QUALIFIED PERSONNEL ONLY!

Unauthorized persons should not attempt to service this device.

- Follow the recommended checkout procedures in Section III to ensure optimum operation of the PD 1200. Be sure to make thorough visual inspections, especially on cables and wires. Broken or frayed wires may cause interference or loss of signal.
- The design of the PD 1200 has been optimized for use with ZMI accessories. Use only the appropriate ZMI pacer and defibrillator electrodes when operating this product.
- In order to maintain battery charge, keep instrument plugged in when not in use.
- Do not use the PD 1200 in the presence of flammable agents (such as gasoline) or anesthetics. Using the instrument near the site of a gasoline spill may cause an explosion.
- Using the device near or within puddles of water is a shock hazard to the operator, patient, and nearby personnel.

HOW TO USE THIS MANUAL

Who it is for The *ZOLL PD 1200 Pacemaker/Defibrillator Service Manual* is a basic technical reference document designed for hospital engineering personnel whose responsibilities include maintenance and repair of medical equipment.

Purpose Its purpose is to provide the basic information needed to allow clinical engineering staff to identify and/or repair the PD 1200 to the subassembly (printed circuit board) level.

Recommended Use The *Service Manual* should be readily available in the hospital's equipment maintenance library. It will be used for preventive maintenance checks and for troubleshooting when problems are reported.

The *Operator's Guide* (Section II) will be used in training new operator's and for operational reference. This manual should be kept with the PD 1200 unit at all times.

The *Service Manual* consists of several key sections:

Section I: General Information

This section contains a number of important notices and reference material, including safety warnings and ZMI's warranty statement. Be sure to review this section thoroughly before attempting to use or service the PD 1200.

Section II: Operation

The *Operator's Guide* has been reproduced here for convenience and consistency. It should be read and understood before attempting any service procedure.

Section III: Checkout Procedures

This section contains two detailed checkout procedures - a daily procedure and a 6 month procedure. Both should be used routinely to ensure that the PD 1200 is operating within specifications.

Section IV: Basic Maintenance

Several routine checks and procedures need to be performed periodically to assure optimum performance and safety from the PD 1200.

Section V: Troubleshooting Guides

This is the key section of the service manual. It allows the service professional to proceed through a logical sequence of checks to identify which module or subassembly is defective. The guide is organized by replaceable assembly to assist with complete diagnosis.

This section also contains an operational troubleshooting section, one for use by non-technical personnel to respond to common problems detected during PD 1200 operational use.

Section VI: Functional Descriptions

This section provides a basic technical description of each of the PD 1200's main subassembly modules. The information should be thoroughly reviewed before servicing.

Section VII: Schematic Drawings

Major circuit board schematics are included for troubleshooting purposes.

Section VIII: Component Layout Drawings

Major component layout drawings are included for troubleshooting purposes.

Section IX: Disassembly Procedures

Step-by-step instructions are provided for removing subassemblies in the event of failure. Refer to the Service Policy in Section I for return and repair information.

Section X: Replacement Parts

This section contains a detailed listing of ZMI part numbers, their description and the reference designation of the parts on each drawing. It will allow the service person to identify and order replacement parts. It should be noted, however, that the individual parts described for each subassembly are listed for the service person's convenience. No attempt to replace parts to board level should be attempted or the ZMI warranty may be voided.

SERVICE POLICY

The PD 1200 comes with a five-year (parts, labor and use of a factory loaner) warranty for in-hospital use. A two-year warranty is extended for pre-hospital use in ambulances and helicopters. In order to maintain this warranty, the instructions and procedures contained in this manual must be strictly followed.

For additional information, please call ZMI service at 1-800-348-9011.

The ZOLL Pacemaker/Defibrillator will provide trouble free operation without periodic recalibration or adjustment. However, it is suggested that the hospital biomedical engineering department perform a routine test of the device to verify proper operation. (See Section III.)

U.S.A. customers
Should the ZOLL PD require service, it should be returned, in its original container, to:

ZMI Corporation, 500, West Cummings Park, Woburn, MA 01801, Attn: Service Manager

Loan instruments are available for use while repairs are being completed. To request loan equipment, contact ZMI at 1-800-348-9011 (in Mass. 1-617-933-9150). Please try to have the following information available to expedite service:

- A description of the problem
- Department where equipment is in use
- Sample ECG strips documenting problem (if available)
- A hospital Purchase Order to allow tracking of loan equipment

International customers
Should the Zoll PD require service, it should be returned, in its original container, to the nearest authorized ZMI service center.

4. CARING FOR THE BATTERY

The ZOLL PD 1200 uses a medical grade, sealed lead acid 12 volt battery pack. This battery should be kept fully charged and periodically checked for capacity.

1. To ensure maximum operating capacity and cell life the battery should be charged for a full 24 hours between uses. The PD 1200 should be OFF during charging.
2. The PD 1200 can be operated with a partially recharged battery with available battery operating time reduced accordingly.

WARNING:	Regular use of a partially charged battery without fully recharging the battery for 24 hours between uses will result in permanent reduced capacity and premature battery failure. A damaged or depleted battery may interfere with operation of the PD-1200 even when connected to AC power. Use of the defibrillator may be compromised by a depleted battery even when connected to AC power.

CAPACITY:

The PD 1200 should provide a minimum of 1.5 hours of monitoring with a fully charged battery.

Battery capacity should be verified at 6 month intervals for equipment operated primarily from AC line. If the PD-1200 is used frequently (several times per week or more) in the battery mode such as for routine patient transport, the battery pack requires more frequent testing. For these units, battery capacity should be verified every two months.

Capacity Test:

1. Charge the battery for 24 hours with the power switch in the "OFF" position to fully charge the battery.
2. Disconnect unit from AC power.
3. Turn selector switch to the "Monitor On" position.
4. Observe that the PD 1200 monitor operates for a minimum of 1.5 hours.
5. If PD 1200 ran less than 1.5 hours, check the charger output.
6. If charger output is within specifications, replace the battery with a new battery.

Replacement Interval:

The battery should be replaced at a maximum interval of 18 months, regardless of the test results.

Low Battery:

When "LOW BATTERY" message is displayed on the PD 1200 monitor, the unit should be plugged into AC power immediately to ensure continuous operation.

CAUTION

The time from a "LOW BATTERY" indication to instrument shut down varies with battery condition from approximately 20 minutes with a battery in good condition to one minute or less with a battery in poor condition.

Battery Depletion: If the PD 1200 turns off after a "LOW BATTERY" has been displayed due to battery depletion, operation can be restored as follows:

1. Turn selector switch to the "OFF" position.
2. Connect AC power cord to an AC outlet.
3. Set selector switch to the desired operating mode to resume therapy.

NOTE: The selector switch should be switched to OFF then to the "ON" position before selecting desired operating mode.

Special Handling: Lead acid batteries require full recharging after use. Continuous short cycle recharging will result in reduced capacity and early battery failure.

Charger Check: To check the charger output follow the steps below:

1. Turn the PD 1200 selector switch to OFF.
2. Check that AC power cord is plugged into AC outlet.
3. Depress and hold the "Sync" button down.
4. Turn selector switch to "Monitor On" position.
5. Listen for 3 audible beep tones then a five second (approximate) pause followed by two additional audible beep tones and check the display of charging voltage. The display should read 138V (13.8V) to 146V (14.6V).
6. If value displayed is not within the above range, contact your Biomedical/Clinical Engineering department or ZOLL Medical Corporation, Technical Support.

III

CHECKOUT PROCEDURES

Resuscitation equipment must be maintained at peak performance. This section describes two testing procedures:

- **Daily test routine** - can be completed in a few minutes and requires no additional test equipment.
- **Extensive, six-month testing sequence** - verifies proper calibration and operation for each of the PD 1200's major functions.

Preventive maintenance test sequences are also described in Section VIII, **Operational Checks and Procedures**, in the *Operator's Guide*.

Recommended Daily Checkout Procedure III-3
1. Visual Inspections III-4
2. Power-up Sequence Test III-5
3. Pacer Accuracy III-6
4. Delivered Energy and Discharge Buttons Check III-7
5. Recorder Operation Check III-8
6. Maintenance After Use III-9
7. Storage Check III-9

Recommended Six-Month Checkout Procedure III-11
1. Initialize Test III-13
2. High Pot Test III-14
3. Leakage Test III-15
4. Charger and Power Supply Tests III-17
5. Extended Diagnostics Mode Tests III-19
6. ECG Tests III-20
7. Pacer Tests III-22
8. Defibrillator Tests III-26
9. MFE Tests III-30
10. Real Time Clock Check III-31

Daily Checkout Procedure

for

PD 1200

Operational Use

This brief checklist is intended for non-technical personnel.

COPY THIS FORM BEFORE USE!!

If a problem is discovered during the checkout procedure, call your Biomedical Engineering department or ZMI Service Operations.

A more thorough checkout procedure and troubleshooting information is found in the *PD 1200 Service Manual*.

1. VISUAL INSPECTIONS

√	Inspection
	• Check that the unit is clean (with no fluid spills) and nothing is stored on the unit.
	• Inspect the unit and its accessories for physical damage. Check all cables, cords, and connectors for cuts in the insulation, or bent and broken connector pins.
	• Check that paddle surfaces are clean. Remove any gel from the defibrillator paddles to prevent corrosion and accidental shock.
	• Make sure that all disposable supplies are available and in proper condition. *Electrode gel • Monitor electrodes • Recorder paper • alcohol swabs • razors •* antiperspirant, etc.
	• Are two sets of pacing or multi-function electrodes available in sealed packages?

2. POWER-UP SEQUENCE CHECK

√	Inspection
	• Plug in the PD 1200 and set the **SELECTOR SWITCH** to the **OFF** position. *Check :* **BATTERY CHARGING** light is lit. Whenever the power cord is connected to an AC outlet and the battery is in place, this light should remain lit, even when the unit is operating.
	• Turn the **SELECTOR SWITCH** to the **MONITOR ON** position. *Check:* A 3-beep tone indicates the power-up sequence is in process. *Check :* Simultaneously, the **ALARM ON**, recorder **START/STOP**, paddle **CHARGE**, and **SYNC** indicator lights go ON and then OFF again. *Check :* "**READY**" message will be displayed briefly, followed by "**MONITOR ON**", in the lower left of the display screen. *Check :* The ECG size should be 1x. *Check :* "**PADDLES**" or "**ELECTRODES**" should be displayed in upper left of display screen. *Check :* The message "**ECG LEAD OFF**" will be displayed whenever leads I, II, or III have been selected and no ECG cable has been connected, or whenever the lead wires are not attached to a patient.
	• Press buttons and set dials to verify the following functions: *Check :* ECG Size for 2x, .5x, 1x *Check :* Lead Selection for I, II, II, PADDLES or ELECTRODES when multi-function cable is connected. *Check :* Freeze - Monitor trace freezes. *Check :* LEDs light when button is pressed: ALARM ON SYNC (MONITOR ON) START/STOP

3. PACER ACCURACY

√	Inspection
	• Turn the main Selector Switch to **PACER ON**.
	• Turn the **RATE** knob to 150 ppm. • Press the **MARK** button to generate a strip. *Check :* The pace pulses should occur approximately every 10 small divisions (2 large divisions, 1 cm).
	• Press the **4:1** button. *Check :* *The frequency of pulses should decrease to 8 large divisions, 4 cm per pulse.*
	• Turn the **OUTPUTmA** knob to 0 mA. *Check :* There should be no PACE LEAD OFF message.
	• Slowly trun the **OUTPUTmA** knob to 15 mA. *Check :* The PACE LEAD OFF message should appear.

4. DELIVERED ENERGY AND DISCHARGE BUTTONS CHECK

WARNING

USE EXTREME CAUTION IN PERFORMING THE FOLLOWING TESTS!!! KEEP HANDS AND ALL OTHER OBJECTS CLEAR OF PADDLE EDGES WHEN DISCHARGING.

√	Inspection
	• Turn the main Selector Switch to **DEFIB ON 200J**.
	• Install a set of adult paddle electrodes or multi-function electrode cable.
	• Place the paddles in their holders, or plug the multi-function electrode into its test jack.
	• Press the front panel **CHARGE** button. ***Check :*** Charge Ready tone is sounded. ***Check :*** Charge Indicator Light is lit. ***Check :*** The Delivered Energy display on the monitor registers 200 joules.
	• Press each **DISCHARGE** button individually. ***Check :*** The PD 1200 does not discharge.
	• Press and hold briefly both **DISCHARGE** buttons simultaneously. ***Check :*** The message **TEST OK** or **TEST FAILED** should appear on the display. ***Check :*** A brief automatic recorder run provides documentation of the test if the unit is providing delivered energy within specifications (**TEST OK**). If **TEST FAILED** appears, contact your hospital's bio-medical staff or ZMI immediately.

5. RECORDER OPERATION CHECK

√	Inspection
	• Press the **MARK** button. *Check :* The recorder will run for 15 seconds.
	• While the recorder is running, press and hold the **UP** and **DOWN ARROWS** located inside the paper compartment. *Check :* This will generate calibration pulses.
	Check : Inspect the recorder waveform for uniformity and darkness. *Check :* Inspect for uniformity of annotation characters and completeness of words. *Check :* Check for down arrow printed below annotation. *Check :* Check recorder speed by verifying that a new calibration pulse appears approximately every 13 small divisions (1.3 cm). See diagram below.
	Check : Check for adequate supply of paper.

6. MAINTENANCE AFTER USE

√	Inspection
	• Carefully clean the defibrillator electrodes and/or paddles. Do not use ammonia to clean plastic parts.
	• Inspect the defibrillator cables and electrodes for visual damage.
	• Review your inventory checklist for accessories and supplies to ensure that all supplies are refilled and returned to their proper place after each use.
	• Keep the PD 1200 plugged into an AC outlet when not in use. The front panel **BATTERY CHARGING** light should be ON at all times.
	• Report any problems to the Clinical Engineering Department.

7. STORAGE CHECK

√	Inspection
	• Be sure to keep the PD 1200 plugged into an active AC power outlet whenever it is not in use. This will keeep the battery fully charged for future use. A battery left uncharged for excessive periods (4 to 6 months) may become damaged and require replacement.

Six-Month
Checkout Procedure
for the
PD 1200

This procedure and checklist is intended for technical personnel and requires the use of additional tools and equipment.

COPY THE CHECKLIST FORM BEFORE USE!!

If a problem is discovered during the checkout procedure, use the Troubleshooting Guides in Section V to isolate or resolve the problem.

For additional assistance, contact ZMI Service Operations.

SIX-MONTH CHECKOUT PROCEDURE

This section of the Service Manual contains a series of checkout procedures to be performed by medical technicians on a routine basis (recommended for six-month intervals) to ensure quality operation of the PD 1200. Some tests require specialized testing equipment and trained personnel. Each test sequence lists the tools required and the frequency with which the test should be performed.

ZMI recommends that a routine testing procedure be established for your ZOLL PD 1200 equipment based on the forms supplied in this section.

Testing Notes

Be sure to complete all actions for a **Step** before looking for results.

Fill in the **Value** column with a checkmark (√) if the correct result (shown in the **Look for** column) is achieved or with a specific value where a test reading has been made.

For troubleshooting information, refer to Section V in this manual.

Recommended Six-Month Checkout Procedure III-11
1. Initialize Test III-13
2. High Pot Test III-14
3. Leakage Test III-15
4. Charger and Power Supply Tests III-17
5. Extended Diagnostics Mode Tests III-19
6. ECG Tests III-20
7. Pacer Tests III-22
8. Defibrillator Tests III-26
9. MFE Tests III-30
10. Real Time Clock Check III-31

1. INITIALIZE TEST

The Initialize Test verifies that the PD 1200 unit is:

- electrically connected
- basic LEDs, sensors, and message codes are operating
- recorder paper is properly installed

1.1 Initialization

- Plug the unit into an AC outlet.
- Turn Mode Select switch to MONITOR ON.

Battery Charge Light is on.
Listen for 3 beep audible tone.
SYNC button LED goes ON, then OFF.
READY message displayed for 4 seconds.
Mark the Checkout Procedure Data Sheet.

1.2 Recorder Check

- Make sure there is no paper in the paper well.
- Press the Recorder START/STOP button.

START/STOP LED goes ON.
PAPER OUT message is displayed.
Mark the Checkout Procedure Data Sheet.

1.3 Recorder Paper Check

- Put a roll of paper in the well and feed the paper into the recorder. Check that paper is fed in correctly.

PAPER OUT message is removed.
Mark the Checkout Procedure Data Sheet.

1.4 Power Off Test

- Turn the PD 1200 OFF.

The ALARM ON button LED goes ON, then OFF as the system shuts down.

2. HI POT TEST

Equipment Required:	• Hipotronics Hipot tester HD-100 or equivalent

2.1 HD-100 Setup

- Set the Hipotronics HiPot Tester HD100 (or an equivalent substitute) controls as follows:

Power	Off
Voltage Range	Low
Sensitivity	Min (C.W.)
Output & Current	5 mA AC
Lower Voltage	Min (C.C.W.)

2.2 PD 1200 Setup

- Place the HI Voltage lead from the PD 1200 HIPOT Duplex Box into the HD-100 A/C Out connector.
- Plug the PD 1200 power cord into the Duplex Box.
- Place GND lead from the HD-100 to the GND jack on the Duplex Box.
- Place the PD 1200 mode switch to MONITOR ON.

2.3 HD-100 Setup

- Turn the HD-100 power switch on.
- Press the HIGH VOLTAGE ON push button.
- Adjust the RAISE VOLTAGE control to 1.5 (1.5 KVac).

The Milliammeter should read below 1.0 on the lower scale (red digits).

2.4 Test Procedure

- After 20 seconds, return the RAISE VOLTAGE control to the ZERO START position.
- Depress the HIGH VOLTAGE OFF push button.
- Turn the PD 1200 to OFF.
- Disconnect from the HD-100.

Mark the Checkout Procedure Data Sheet.

3. LEAKAGE TESTS

Equipment Required:	• Bio-design Microguard MG-6 or equivalent

3.1 Test Setup

- Connect the ECG cable, pacer cables, and ground leads to the PD 1200.
- Plug PD 1200 power cable into the orange A/C plug located on the Bio Design MicroGuard MG-6 or equivalent.
- The ground lead from the MG-6 goes to the banana plug marked with <gnd-symbol> on the back plate of the PD 1200.
- Settings on the MG-6 should be as listed below.

Selector	200 uA
Patient Lead	All other tests
Power	Off
Neutral	Closed
White input	Switch to the right.

- Place the PD 1200 main Selector Switch to MONITOR ON. Be sure that PADDLES are installed and selected as leads.

3.2 Test Procedure

- Place MG-6 power switch to normal and GND to normal.

Note the digital display in uA.

- Depress the GND lift switch.

Note digital display.

- Place the MG-6 power switch to reverse and repeat.

Mark the Checkout Procedure Data Sheet.

3.3 Repeat Procedure

- Set MG-6 patient lead switch to RA position.
- Repeat step 3.2 with the pacer, ECG, paddle, and MFE cables alternately connected to the RA jack on the patient lead tester.

Mark the Checkout Procedure Data Sheet.

3.4 ECG Risk Current Test Procedure

- Place MG-6 patient lead switch to 120 VAC position.
- Connect the ECG cable to RA jack.
- Depress "TO ALL LEAD" button.

Note digital display (subtract 2 uA from reading).

See **Leakage Acceptance Limits table** on following page.

LEAKAGE ACCEPTANCE LIMITS

Case to AC Ground	100 uA Max
ECG Leads to Ground	10 uA Max
Pacer Leads to Ground	10 uA Max
Risk Current (ECG)	20 uA Max
Risk Current (Pacer)	20 uA Max
Paddle Leads to Ground	100 uA Max
Paddle Risk Current	100 uA Max
Risk Current (ECG unshielded)	10 uA Max
MFC leads to ground	100 uA Max
MFC risk current	100 uA Max

3.5 Repeat Procedure

- Place pacer cable in RA jack.
- Repeat step 3.4.

3.6 Repeat Procedure

- Set to DEFIB mode with PADDLES as leads. Place paddle cable from paddle leakage TEST BOX into the R.A. jack.
- Repeat step 3.4.

3.7 Repeat Procedure

- Place multi-function cable (MFC) from paddle leakage TEST BOX into the RA jack.
- Repeat step 3.4.

3.8 Repeat Procedure

- Remove the standard ECG cable and install an unshielded ECG test cable in its place.
- Repeat step 3.4.

4. CHARGER AND POWER SUPPLY TESTS

Equipment required:	• Charger/power-supply test fixture (ZMI part # 1002-0109) • Hewlett-Packard HP63286A power supply or equivalent.

4.1 Test Setup

- Unplug the PD1200 AC power cord.
- Open the battery compartment door and disconnect the battery.
- Attach the connector labelled "Charger" on the Charger/power-supply test fixture to the charger connector in the battery compartment.
- Turn on the power supply and adjust the output to 12V.
- Turn off the power supply.
- Plug the cable labelled "+12V" to the positive terminal of the power supply and the cable labelled "GND" to the common or GND terminal on the supply.

> **CAUTION**
>
> **DO NOT reverse the polarity on the +12V and GND cables as it may cause damage to the unit.**

- Plug in a DVM to the terminal labelled "DVM+" and "DVM-".
- Turn on the power supply.
- Adjust the power supply so that the DVM reads 12.00V.

4.2 Charger/Power Supply Tester Setup

- Set the Charger/Power Supply Tester's MODE switch to Charger.

4.3 Test Procedure

- Plug the PD 1200 into an AC outlet.

Observe:

The "BATTERY CHARGING" LED is on.

The meter display falls between 14.08 and 14.48 Vdc (Charge Voltage).

Mark the Checkout Procedure Data Sheet.

4.4 Voltage Check Tests

- Unplug the PD 1200.
- Set the MODE switch to "POWER SUPPLY" on test fixture.
- Turn PD-1200 to MONITOR ON.

The current meter on the supply should settle at 1.0 Amps or less.

Mark the Checkout Procedure Data Sheet.

- Turn off the unit while watching the ALARM LED.

The LED should blink before the unit shut off indicating that the X-SHUTDOWN signal is functioning.

Mark the Checkout Procedure Data Sheet.

- Turn the unit back on.
- Adjust the power supply voltage to 11.8V.
- Slowly turn the voltage control down (use the fine voltage control knob if it exists) until a LOW BATTERY message is displayed on the CRT.

Mark the Checkout Procedure Data Sheet.

4.5 Test Procedure

- Set the supply voltage to 11.3V.
- Slowly turn the voltage control down (use the fine voltage control knob if it exists) until the unit shuts off.

Mark the Checkout Procedure Data Sheet.

4.6 Battery Disconnect Override Test Procedure

- Turn PD 1200 rotary switch to OFF.
- Turn the rotary switch back to MONITOR ON and start timing on a stop-watch when the 3 beeps are heard.

The unit should remain on for at least an additional three seconds indicating the low battery shutdown override is functioning.
Mark the Checkout Procedure Data Sheet.

4.7 System Current Test Procedure

- PD1200 power is off and the unit is unplugged.
- Set the DVM to 200 mv.
- Set the System current switch to "CURRENT SENSE" mode.

The reading should less than 17.5mV, representing 175 uA.
Mark the Checkout Procedure Data Sheet.

4.8 Test Completion

- Turn off unit.
- Disconnect the PD 1200 from the test fixture and reconnect the battery cable and charger cable.
- Close the battery compartment.
- Plug the unit into AC power.

4.9 Set the correct date and time.

- Open the recorder door.
- Press and hold the ALARM SET button while turning the unit to MONITOR ON.
- Use the *UP ARROW* and *DOWN ARROW* buttons to set the DATE.
- Press ALARM SET again to input that date.

Repeat the last two steps for the MONTH, YEAR, and TIME of DAY.

- Turn off the unit.

5. EXTENDED DIAGNOSTICS MODE TESTS

5.1 Enter Extended Diagnostics Mode

To power up the PD 1200 in extended diagnostics mode:

- Press and hold the SYNC button for at least 3 seconds (until two beeps are heard and the SYNC LED goes off) while turning the rotary switch to MONITOR mode.

5.2 Test Procedure

- Turn the rotary switch to PACER mode.
- Set rate to 40ppm and press the 4:1 button.
- Set rate to 100ppm and press the 4:1 button.
- Set rate to 40ppm and press the 4:1 button.

5.3 Test Procedure

- Set the front panel switch to **PACER MODE.**
- Set the pacer rate pot to 30, 80, 180 ppm.

Check that the CRT displays those values +/-7ppm.
Mark the Checkout Procedure Data Sheet.

5.4 Test Procedure

- Set the pacer output pot to 20, 80, 140mA.

Verify that the CRT displays those values +/-7mA.
Mark the Checkout Procedure Data Sheet.

5.5 Hislew Test

- Set the front panel switch to **MONITOR MODE.**
- Connect the defibrillator paddles to the PD 1200.
- Select lead paddles.
- Tap one of the paddles and observe:
  A small "lightning bolt" appears in the upper right corner of the display, then disappears.

Mark the Checkout Procedure Data Sheet.

5.6 Baseline Reset Test

- While shaking the paddles, hold the freeze button and observe:
  The baseline becomes flat while the freeze is pressed, noisy when the freeze button is released.

Mark the Checkout Procedure Data Sheet.

6. ECG TESTS

Equipment required:	• Calibrated ECG simulator with 60Hz sine-wave output capability. • Oscilloscope with probes. • Phono jack for measuring output signal from rear panel jack.

6.1 Enter Extended Diagnostics Mode

To power up the PD 1200 in extended diagnostics mode:

- Press and hold the SYNC button for at least 3 seconds (until two beeps are heard and the SYNC LED goes off) while turning the rotary switch to MONITOR mode.

6.2 Test Setup

- Set to lead 1.
- Connect the ECG leads to the simulator and to the PD 1200.
- Set the ECG Simulator to: BPM = 120, AMPLITUDE = 1 MV.
- The H.R. display should read 120 +/- 2 BPM.

6.3 Test Procedure

- Break each ECG lead sense line by removing leads one, two, and three one at a time from the simulator.

ECG LEADS OFF should be displayed on upper quadrant of the monitor.
Mark the Checkout Procedure Data Sheet.

6.4 Volume Control Test Procedure

- Adjust the QRS Volume Control Knob fully towards the outside of the unit. No sound should be heard.
- Adjust Volume Control fully towards the center of the unit. QRS Detection Tone should increase in volume to an acceptably high limit.

Mark the Checkout Procedure Data Sheet.

6.5 Test Procedure

- Set LEAD = 1 and SIZE = 1x.
- Step the size switch through each setting.

The display should change to reflect each SIZE.
Mark the Checkout Procedure Data Sheet.

6.6 Test Procedure

- Depress and hold the FREEZE button.

The moving QRS display should stop moving.

- Release the Freeze button.

The QRS complexes should be moving.
Mark the Checkout Procedure Data Sheet.

6.7 Test Procedure

- Set an oscilloscope as follows:
  .5 Volts per division.
  .2 Seconds per division.
- Connect the scope probe to the "ECG OUT" signal cable.

The QRS complex display should appear on the oscilloscope having an amplitude of 1 Volt +/- 0.2V p-p.
Mark the Checkout Procedure Data Sheet.

6.8 Repeat Procedure

- Connect an x1 scope probe to the output connector cable from the rear of the PD 1200.
- Repeat step 6.7.

The ECG output should have less than 200 mV p-p of noise.
Mark the Checkout Procedure Data Sheet.

6.9 Test Procedure

- Set size to X1.
- Depress and hold the UP ARROW ▲ and DOWN ARROW ▼ buttons to activate the Calibration Signal.
- Press the Recorder MARK button.

Observe a down-arrow on the stripchart and the correct date and time.
The recorder should stop in 15+/-3sec.
The strip chart should display a signal of 120 ppm with an amplitude of 10 mm +/- 1 mm.
Mark the Checkout Procedure Data Sheet.

6.10 Notch Filter Test Procedure

- With the PD 1200 in MONITOR mode, set to LEAD I, at gain 2x : apply a 1mV p-p 60Hz sine wave from the simulator to the ECG input.

Verify that the waveform on the recorder is less than 1mm.
Mark the Checkout Procedure Data Sheet.

- Turn the ECG simulator off.

7. PACER TESTS

Equipment required:
- Pacer Output Load Resistor, which consists of a 5Watt or greater, 1KΩ resistor.
- Oscilloscope
- Signal generator
- Frequency counter
- Calibrated ECG Simulator with 60 Hz sinewave output capability
- ZMI External Pace Triggering Cable (option # 9500-0022)

Measurements are made with an oscilloscope probe connected to the positive (sternum) side of the resistor, and with the ground of the probe connected to the negative side. For the standard pacer output connector at the front of the PD 1200, the positive side is the uppermost of the two output pins; for the MFE cable, the positive side is the rightmost high voltage pin with the label facing up.

7.1 Pacer Safety Relay Check

- Connect a set of paddles to the PD 1200.
- Place the paddles in their pockets.
- Plug the pacer output load resistor into the pacer output connector.
- Set the main Selector Switch to MONITOR ON.
- Select PADDLES and SIZE 1.
- Connect the signal generator across the output load and adjust the generator to output a 10Hz 0.5Vp-p sinewave.
- Press the MARK button and allow the stripchart to run for 1 to 2 seconds.

The baseline noise should be less than 2 mm.

Mark the Checkout Procedure Data Sheet.

7.2 Repeat Test

- Reverse the polarity of the signal generator outputs and repeat test 7.1.

The baseline noise should be less than 2 mm.

Mark the Checkout Procedure Data Sheet.

- Disconnect the signal generator from the output load.

7.3 Test Procedure

- Place the main selector switch to PACER ON.
- Adjust RATE to 120 PPM.
- Connect the pacer output load resistor to the standard pacer output connector at the front of the PD 1200.
- With the frequency counter and oscilloscope connected to the test load, turn the OUTPUT knob to 0.

The display on oscilloscope should show 0 volts.

Mark the Checkout Procedure Data Sheet.

- Set the scope as follows:
  20 mV per division.
  .2 or .5 Sec per division.
- Watch the scope display while switching the mode selector from PACER ON to OFF.

There should be no spikes and/or transients.

- Turn the mode switch to PACE. Again no spikes should appear on the scope.

Mark the Checkout Procedure Data Sheet.

7.4 Test Procedure

- Set the OUTPUT knob to 15mA.
- Disconnect the pacer output load cable from the PD 1200.

PACER LEADS OFF appears in the lower half of the display.
Mark the Checkout Procedure Data Sheet.

7.5 Test Procedure

- Reconnect the pacer output load cable.

The **PACER LEADS OFF** display is replaced by **PACER ON**.
Mark the Checkout Procedure Data Sheet.

7.6 Test Procedure

- Set the RATE knob to 180 ppm.
- Set the OUTPUT knob to 0.

Note the output current reading on the PD 1200 and the actual wave amplitude on the scope.
The digital display will match the OUTPUTmA setting +/- 7 mA.
The pulse voltage shall be 1V per mA (i.e. 20mA = 20 +/- 7V) for each set point.
Mark the Checkout Procedure Data Sheet.

7.7 Repeat Procedure

- Repeat step 7.5 for each point setting on the OUTPUTmA dial (20, 40, 60, 80, 100, 120, 140, MAX).

Mark the Checkout Procedure Data Sheet.

7.8 Test Completion

- Set the OUTPUTmA knob to zero.

There should be zero volts on the scope.
Mark the Checkout Procedure Data Sheet.

7.9 Test Procedure

- Set OUTPUT knob to 60 MA.
- Measure the pulse period (frequency) and pulse width at the following RATE settings: MIN, 40, 60, 80, 100, 120, 180 and MAX (fully clockwise).

Pulse period (frequency) shall be within +/- 5% at each setting.
The pulse width will be 40 mS +/- 1 mS at each setting.

- Measure the pulse width only where specified.

Mark the Checkout Procedure Data Sheet.

Dial Setting	Frequency Tolerance	Pulse Width Tolerance
MIN	Record Only	39-41 mS
40	1428 - 1578	
60	952 - 1052	
80	714 - 789	
100	571 - 631	39-41 mS
120	476 - 526	
180	317 - 350	
MAX	Record Only	39-41 mS

7.10 External Pace Tests

Section 7.10 can be performed only if the unit has the ZMI External Pace Triggering Cable (option # 9500-0022) installed.

7.10.1 Test Procedure

- Connect the external pace test cable to the auxilliary port of the PD1200.

EXT TRIG will appear on the CRT.
Mark the Checkout Procedure Data Sheet.

7.10.2 Test Procedure

- Attach a TTL-level square wave generator to the external pace cable. The square-wave generator should be off.
- Set the front panel pace rate knob to 30ppm.

Verify that the pace output pulse period is 2000 +/- 50ms.
Mark the Checkout Procedure Data Sheet.

7.10.3 Test Procedure

- Turn on the waveform generator.
- Set the waveform generator to 1Hz.

The output pulse period should now be at 1000 +/- 25ms.
Mark the Checkout Procedure Data Sheet.

7.10.4 Test Procedure

- Increase the waveform generator frequency to 7Hz.

Verify that output period is at 143+/- 15ms.
Mark the Checkout Procedure Data Sheet.

7.10.5 Test Procedure

- Increase generator frequency to 10Hz.

The output period should increase to 200 +/- 15ms.
Mark the Checkout Procedure Data Sheet.

- Turn off the waveform generator. Disconnect the output cable from the waveform generator.

7.10.6 Test Procedure

- Select LEADS with the simulator set to 60 BPM so that QRS detections are occuring.
- Attach the scope probe across the external pace cable pins.

Observe one negative-going square pulse for each QRS complex (a flashing heart on the CRT). The amplitude of the square pulse should be 50 +/- 10mV.
Mark the Checkout Procedure Data Sheet.

- Disconnect the external pace cable and the pacer output cable.

7.11 MFE Pace Output Test Procedure

- Connect the MFE cable to the unit.
- Connect the test load to the MFE cable outputs.
- Connect the scope across the MFE pace output load.
- Turn the pace amplitude to 60mA and the rate to 180ppm.

A positive-going pulse should be observed on the scope.
Mark the Checkout Procedure Data Sheet.

8. DEFIBRILLATOR TESTS

Equipment required: • Dynatech Nevada Impulse 3000 or equivalent.

WARNING

USE EXTREME CAUTION IN PERFORMING THE FOLLOWING TESTS!!! KEEP HANDS AND ALL OTHER OBJECTS CLEAR OF PADDLE EDGES WHEN DISCHARGING.

8.1 Enter Extended Diagnostics Mode

The PD 1200 should still be in diagnostics mode from the previous tests. If it has been turned off since the previous tests, perform the following steps:

- Press and hold the SYNC button for at least 3 seconds (until two beeps are heard and the SYNC LED goes off) while turning the rotary switch to MONITOR mode.
- Paddles should NOT be in the unit.
- Select paddles as leads.
- Press the MARK button and allow the stripchart to run for 10 seconds. The baseline noise shoulde be less than 1 mm.

Mark the Checkout Procedure Data Sheet.

- Turn the mode selector switch to DEFIB ON 100 JOULES.

PADDLE FAULT should be displayed on the CRT.
Mark the Checkout Procedure Data Sheet.

8.2 Test Procedure

CAUTION: NO MORE THAN 3 DISCHARGES PER MINUTE!

- Plug in the Internal Paddle Connector.

PADDLE FAULT is replaced by DEFIB ON.
Mark the Checkout Procedure Data Sheet.

- Select 100J.
- Press the CHARGE button on the front panel.

Observe:

50J MAX on the monitor.
The display over joules digitally counts up to 50.
The audible Defib Ready tone sounds.

Mark the Checkout Procedure Data Sheet.

- When the audible tone sounds, set the mode selector to the next higher Joule setting to dump energy.

  Observe:

  The audible Defib Ready tone stops.

  The energy discharges.

  The 50 is removed from the display.

Mark the Checkout Procedure Data Sheet.

- Set the rotary switch back to 100J.
- Connect the standard defib paddle to the unit.
- Make sure paddles are firmly in pockets.
- Press the CHARGE button.

The charge time displayed on the CRT should be greater than 4.5s.

Mark the Checkout Procedure Data Sheet.

- Press the discharge buttons.

The unit should discharge and the 100 should be removed from the display.

Mark the Checkout Procedure Data Sheet.

8.3 **Test Procedure**

- Turn the mode selector switch to DEFIB ON 200 JOULES.
- Press the CHARGE button on APEX paddle.
- Wait for the audible Defib Ready tone and the red LED on theApex paddle will light.
- Press and release the APEX paddle discharge button only.

The unit should NOT discharge.

Mark the Checkout Procedure Data Sheet.

- Press and release the Sternum paddle discharge button only.

The unit should NOT discharge.

Mark the Checkout Procedure Data Sheet.

- Press both discharge buttons.

Observe:

The unit discharges.

IPEAK value on monitor should be 100 +/- 8.

Mark the Checkout Procedure Data Sheet.

- Check the strip chart for the annotation on strip chart: TIME, DATE LEAD, SIZE, H.R., 200J

8.4 **Test Procedure** (requires two sets of paddles)

- The ECG leads should be connected to the simulator and the unit and the ECG Simulator set to: BPM = 120,
- AMPLITUDE = 1 MV. Select LEAD 1.
- Turn off the unit. Wait 5 seconds.
- Turn the rotary switch back to 200J.

The PD 1200 will now be in normal (non-diagnostic mode).

- Place the defibrillator paddles firmly on the appropriate paddle pads of the Defib tester.
- Put a set of dummy paddles in the pockets, if available.

- Press the CHARGE button on the APEX paddle.
- When the audible Defib Ready tone sounds, discharge the paddles into the tester.

Observe:

The unit discharges.
No disturbance of the QRS waveform baseline.
TEST FAIL message on monitor.
The strip chart annotation shows TEST FAIL.

Mark the Checkout Procedure Data Sheet.

8.5 **Test Procedure**

- Press the SYNC button on the PD 1200.

Observe:

A SYNC marker on the monitor (a higher intensity line on the ECG R-wave peaks)
SYNC DEFIB is displayed on the monitor.

Mark the Checkout Procedure Data Sheet.

8.6 **Test Procedure**

- Place the defib tester beside the PD 1200.
- Connect the PD 1200 ECG patient cable to the Dynatech Impulse 3000 defib tester (or equivalent) output terminal jacks, observing the correct color codes.
- Press the "Cardio" switch (or enter synchronized cardioversion timing test mode on other units).
- Select PADDLES as lead, X1 gain.
- Press the SYNC button.

Observe :

SYNC USE LEADS message.
QRS complexes of 10 mm +/- 5mm amplitude.
Heart Rate = 60 BPM +/- 2.
The Heart symbol on the CRT blinks on and off.

Mark the Checkout Procedure Data Sheet.

8.7 **Test Procedure**

- Disconnect the ECG cable from the PD 1200.
- Set the joule setting on the PD 1200 to 360J and select lead 1.
- Press the CHARGE button on the APEX paddle.

The charge time displayed on the CRT should be between 7.5 and 9.5 seconds.
Mark the Checkout Procedure Data Sheet.

- When the charge tone is sounded, depress and hold the discharge buttons on the paddles (for at least 5-10 seconds).

The PD 1200 will not discharge (because there is no ECG wave to SYNC on).
Mark the Checkout Procedure Data Sheet.

- Reconnect the ECG cable to the PD 1200.

8.8 **Test Procedure**

- Press and hold the Paddle Discharge buttons.

Observe:

The defibrillator discharges.

The ECG waveform should return to baseline within 4 seconds.

The energy displayed on Dynatech should be 324 - 396J.

The number displayed is 30 mS. or less.

Mark the Checkout Procedure Data Sheet.

- Repeat for all energy settings.
  (The limits are +/-15% or 4 Joules, whichever is greater).

8.9 **Test Procedure**

- Select PADDLES as leads.
- Press the charge button and discharge the unit into the Defib tester.

The ECG display should show a negative-going wave following the initial transient (only if the tester has "play back" capabilities).

Mark the Checkout Procedure Data Sheet.

9. MFE TESTS

9.1 Test Setup

- Power on the unit and set the Selector Switch to 2J.
- Make sure there is paper installed in the printer.
- Remove the defibrillator paddles from unit.
- Install the MFE cable.

Verify that **ELECTRODES** appears on the display.
Mark the Checkout Procedure Data Sheet.

9.2 Test Procedure

- With the MFE cable installed but not plugged into the test connector, charge the PD 1200 to 2J.

> **WARNING!**
>
> **Keep the cable away from human and/or metal contact.**

- Press the DISCHARGE buttons.

Verify that the message **ELECTRODES OFF** appears.
Mark the Checkout Procedure Data Sheet.

9.3 Test Procedure

- Plug the MFE cable into the self-test connector located in the front handle.
- If the unit is not still charged, charge it to 2J.
- Discharge into the test connector.

Verify that the unit successfuly discharges into the load.
Mark the Checkout Procedure Data Sheet.

- Turn the unit off, then on again so that it is no longer in self test mode.

9.4 Test Procedure

- With the MFE cable still plugged into its test connector, charge the unit to 200J and discharge.

Verify: The message **TEST OK** appears on the CRT.
The message **TEST OK** appears on strip chart.

10. REAL TIME CLOCK CHECK

10.1 Test Procedure

- Press the MARK button to get a print-out on the stripchart of the date and time. Verify that the date and time are still correct.

PD 1200 CHECKOUT PROCEDURE

DATA SHEET

S/N _____ OPERATOR _____ DATE _____

COPY THIS FORM BEFORE USING ! !

SECTION 1. INITIALIZE TEST

Plug in the unit. Turn the rotary switch to MONITOR ON.

1.1 Battery Charge Light on _____
3 Beep Audible Tone _____
Sync Light _____
READY for 4 seconds _____

1.2 *Remove paper from recorder.*
PAPER OUT _____
Recorder start/stop _____

Put paper into the recorder
PAPER OUT message is removed. _____

SECTION 2. HIGH POT TESTS

2.4 HiPot @ 1.5kV for 20 seconds _____

SECTION 3. LEAKAGE TEST

			GND Normal	GND Lift
3.2	Chassis	Normal	_____	_____
		Reversed	_____	_____
3.3	ECG	Normal	_____	_____
		Reversed	_____	_____
	Pacer	Normal	_____	_____
		Reversed	_____	_____
	Paddles	Normal	_____	_____
		Reversed	_____	_____
	MFC	Normal	_____	_____
		Reversed	_____	_____
3.4	ECG Risk		_____	_____
	Pacer Risk		_____	_____
	Paddle Risk		_____	_____
	ECG Risk (unshielded)		_____	_____
	MFC Risk		_____	_____

SECTION 4. CHARGER AND POWER SUPPLY TESTS

4.3	Battery charging LED on	_____
	Charger voltage 14.08 - 14.48	_____
4.4	System current with unit on less or equal to 1A	_____
	ALARM LED blinks on turn-off	_____
	LOW BATTERY voltage 11.66 +/- 0.2V	_____
4.5	Shutdown voltage 11.14 +/- 0.15V	_____
4.6	Battery disconnect override >3s	_____
4.7	DVM reading <= 17.5mV	_____
4.9	Set correct date and time	_____

SECTION 5. EXTENDED DIAGNOSTICS MODE TESTS

Power up the PD 1200 in extended diagnostics mode.

5.3 *Set unit to pace mode. Set pace rate knob to 30, 80, 180ppm.*
Pace rate display 30, 80, 180 +/- 7 _____

5.4 *Set pace output knob to 20, 80, 140mA.*
Pace output display 20, 80, 140 +/- 7 _____
Power down unit. Disconnect TP1 and TP2.

5.5 *Connect defibrillator paddles, select paddle leads, tap paddles.*
Lightning bolt _____

5.6 *Shake paddles and press FREEZE button.*
Baseline reset _____

SECTION 6. ECG TESTS

Power up unit in self-test mode, lead 1. Connect simulator to unit and set simulator to 120BPM, 1mV amplitude.

6.3 *Disconnect each lead and check for LEADS OFF. Repeat for lead select settings II, III.*
ECG leads off _____

6.4 *Check volume control adjustment.*
QRS Volume OFF _____
QRS Volume ON _____

6.5 *Select lead 1, and step through size select.*
Lead 1 Size Select _____

6.6 *Press FREEZE button.* QRS Frozen _____
Release FREEZE button. QRS moving _____

6.7 *Connect scope probe to ECG OUT jack.*
ECG out 1+/- 0.2V _____

6.8 *Connect scope probe to rear panel ECG.*
ECG out rear panel 1V +/- 0.2V and < 200 mV noise p-p _____

6.9 Cal pulse _____

6.10 *Select lead 1, size 2X. Set simulator to output 1mV 60Hz.*
Recorder waveform <1mm _____

SECTION 7. PACER TEST

7.1 *Pacer Safety Relay Check*
Baseline noise is less than 2 mm _____

7.2 *Reverse polarity of the signal generator.*
Baseline noise is less than 2 mm _____

7.3 *Set unit to PACE mode, 120ppm, 0mA output. Connect pace output load cable, frequency counter, and scope.*
0 mA output _____
Turn off unit and turn back on checking for transients.
No spikes/transients _____

7.4 *Turn output knob to 15mA. Disconnect pacer cable.*
PACER LEADS OFF on CRT _____

7.5 *Reconnect pacer cable.*
PACER LEADS OFF is removed. _____

7.6 *Set output to 20mA.*

		Display	Actual
7.7	20mA +/- 7mA	_____	_____
	40mA +/- 7mA	_____	_____
	60mA +/- 7mA	_____	_____
	80mA +/- 7mA	_____	_____
	100mA +/- 7mA	_____	_____
	120mA +/- 7mA	_____	_____
	140mA +/- 7mA	_____	_____
	MAX	_____	_____
7.8	0mA	_____	_____

7.9 *Measure pulse period and width.*

Dial Setting	Frequency	Pulse Width
MIN		
40		
60		
80		
100		
120		
180		
MAX		

Perform steps 7.10.1 through 7.10.6 only if the unit has the external pace trigger option.

7.10.1 *Connect external pace cable with waveform generator to auxilliary port.*
EXT TRIG CRT display _____

7.10.2 *Set pace rate pot to 30ppm.*
Output pulse 2000+/- 50mS _____

7.10.3 *Turn on waveform generator and set frequemcy to 1Hz.*
Output pulse 1000+/- 25mS _____

7.10.4 *Set generator frequency to 7Hz.*
Output pulse 143+/- 15mS _____

7.10.5 *Set generator frequency to 10Hz.*
Output pulse 200+/- 15mS _____

7.10.6 *Select test leads, turn off generator, and attach scope probe across external pace cable.*
50+/-10mV QRS detect pulse _____

7.11 *Connect the MFE cable to the unit. Connect the test load to the MFE cable outputs. Connect the scope across the MFE pace output load. Turn the pace amplitude to 60mA and the rate to 180ppm.*
A positive-going pulse should be observed on the scope. _____

SECTION 8. DEFIBRILLATOR TESTS

8.1 *No paddles in unit. Unit should be in extended diagnostics mode.*
Set rotary switch to 100J setting.
PADDLE FAULT message on CRT _____
Less than 1 mm of noise on baseline _____

8.2 *Plug in internal paddles.*
DEFIB ON message _____
Press Charge button.
50J MAX _____
50 is displayed _____
Apex light _____
Audible tone _____
Select next higher energy setting.
Audible tone stops _____
Energy dumps _____
Apex paddle LED goes out _____
50 is removed _____

Select 100J setting. Connect standard defib paddle to the unit. Make sure paddles are firmly in pockets. Press Charge button.
Charge time on CRT greater than 4.5 sec. _____
Press discharge button.
100 is removed _____

8.3 *Set rotary switch to 200J setting. Press Apex paddle charge button.*
Press Apex => no discharge _____
Press Sternum=> " " _____
Press Both => Discharge _____
DEFIB ON message _____
IPEAK = 100+/-5 _____

8.4 *Connect simulator to unit and set simulator to 120BPM, 1mV amplitude, select LEAD 1. Power down unit . Turn rotary switch back to 200J. Place dummy paddles in pockets, and defib paddles in the defib tester. Charge defib and discharge.*
No QRS baseline disturbance _____
TEST FAIL message _____

8.5 *Press SYNC button.*
Sync marker on waveform _____

8.6 *Connect ECG leads to the defib tester. Press CARDIO on defib tester. Select paddles as leads, X1 gain.*
ECG waveform on CRT, 10mm amplitude _____
Remove dummy paddles.

8.7 *Disconnect ECG cable. Set to 360J setting and lead 1. Make sure the SYNC LED is lit. Press charge button and time charge.*

Charge time on CRT 7.5 - 9.5 sec _____

Press discharge buttons.

No discharge _____

Reconnect ECG cable.

8.8 *Charge defib and press discharge buttons.*

Baseline return in <=4sec _____

Energy delivered to defib tester 324 - 396J _____

Number displayed on Dynatech < 30mS _____

2J_____	3J_____
5J_____	7J_____
10J_____	20J_____
30J_____	50J_____
100J____	150J____
200J____	300J____

8.9 *Select PADDLES as leads. Press the charge button and discharge the unit into the Defib tester. The ECG display should show a negative-going wave following the initial transient (if tester has "play back" capability).*

Negative-going wave _____

SECTION 9. MFE TESTS

9.2 *Install MFC.*

"ELECTRODES" appears _____

9.3 *Set to 2J and charge. Attempt discharge.*

"ELECTRODES OFF" (w/o test connector) _____

9.4 *Plug MFC into test connector, charge to 2J and discharge.*

Able to discharge with test connector _____

9.5 *Charge to 200J and discharge.*

"TEST OK" on CRT _____

"TEST OK" on strip _____

SECTION 10. REAL TIME CLOCK TEST

10.1 Correct date and time _____

IV

BASIC MAINTENANCE

Resuscitation equipment must be maintained at peak performance. The following procedures explain simple maintenance tasks that should become part of the equipment operator's regular activities. These procedures are also documented in the *Operator's Guide* for reference in the field.

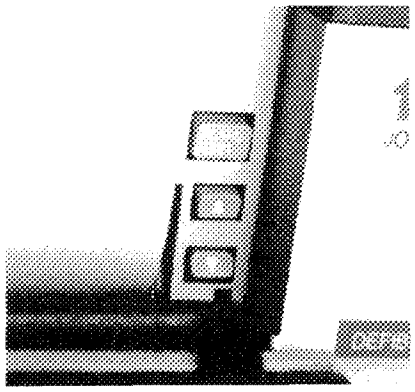
LIST OF PROCEDURES

Description	Page
1. Setting Time and Date	IV-2
2. Changing Paper	IV-3
3. Clearing a Recorder Paper Jam	IV-4
4. Caring for the Battery	IV-5
5. Changing the Battery Pack	IV-5
6. Cleaning the PD 1200	IV-6

1. SETTING TIME AND DATE

Check the time and date on the recorder annotation prior to every use. If it is not correct, use the following procedure to reset it:

1. Turn the **SELECTOR SWITCH** to **OFF**.
2. Open the recorder door by pressing the "paper" latch.
3. Press and hold the **ALARM SET** button under the recorder door. With the **ALARM SET** button pushed, turn the **SELECTOR SWITCH** to the **MONITOR ON** position. When the date display appears on the monitor, release the **ALARM SET** button. The "DATE" message will appear in the lower portion of the screen, indicating the PD 1200's current day, month, and year setting, along with flashing cursors (_ _) under the first value that may be changed. The cursors appear first beneath the current day.



4. Use the ▲ switch to increase the value and use the ▼ switch to decrease the value. Holding down the ▲ switch will increment repeatedly; likewise, holding down the ▼ switch will decrement repeatedly.

   After setting a value, press the **ALARM SET** button to move to the next setting. When the **DATE** setting is complete, the **TIME** setting will automatically be displayed.

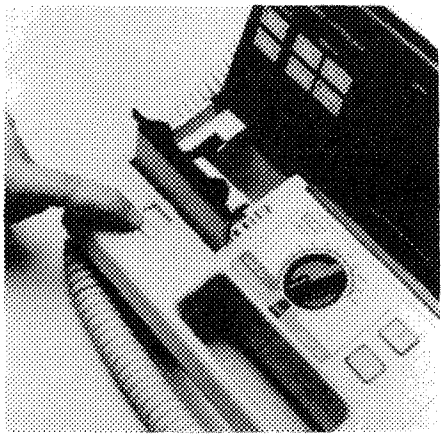
Acceptable settings =	Day	1 to 31
	Month	JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC
	Year	00 to 99
	Hour	00 to 23
	Minute	00 to 59

5. Press the **ALARM SET** button again. The lower portion of the screen returns to the normal **MONITOR ON** display.
6. Verify that the time and date have been correctly set by generating a strip chart recording. Press the **RECORDER START/STOP** button and check that the strip chart is correctly annotated with the current time and date, PADDLES or ELECTRODES, size = 1.0, HR = 0.
7. Check the real-time clock's operation by waiting for several minutes and running the recorder again (see step 6).

Note: *Time and date may require resetting if the batteries have been depleted.*

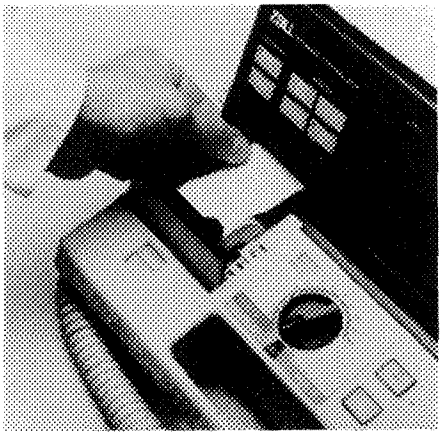
2. CHANGING PAPER

1. Press the recorder release button (the door and paper carriage will tilt up).
2. Remove the empty or low paper roll from the spindle.



3. Place a new roll of thermal paper on the spindle with the paper coming off the top of the roll and the grid facing down.
4. Drop the new roll on the spindle down into the paper cavity.
5. Press recorder **START** so that the light within the switch goes on. (Note that the recorder motor will not start until the paper is inserted.)

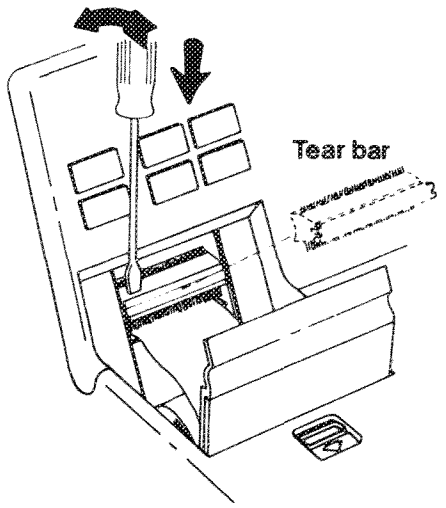
6. Insert the paper (grid face down) into the lower slot until the motor starts and the paper begins to pull through. The paper will soon come through the top slot, grid facing up.
7. Press **STOP** to stop the recorder.
8. Close the cover door.



3. CLEARING A RECORDER PAPER JAM

If the recorder stops printing and there is still paper on the spindle, the paper may be wrapped around the recorder feed roller. To correct this:

1. Pry the paper tear bar out with a screw driver. Pry on one side, then the other, until the bar snaps out.
2. Cut and remove all paper that may have wrapped around the feed roller.
3. When the paper path is clear, test feed approximately one foot of paper. If the paper feeds properly, reinstall the tear bar. The flat edge of bar should be positioned to the bottom.



4. CARING FOR THE BATTERY

A medical grade, sealed lead-acid battery is used in the PD 1200, which, unlike nickel-cadmium (Nicad) batteries, requires no periodic maintenance or charge cycling. In addition, it has no memory and can be recharged rapidly (2-3 hours).

To ensure a fully charged battery, always keep the PD 1200 plugged into an AC power outlet when not in use. Depleted batteries will result in slower defibrillator charging times.

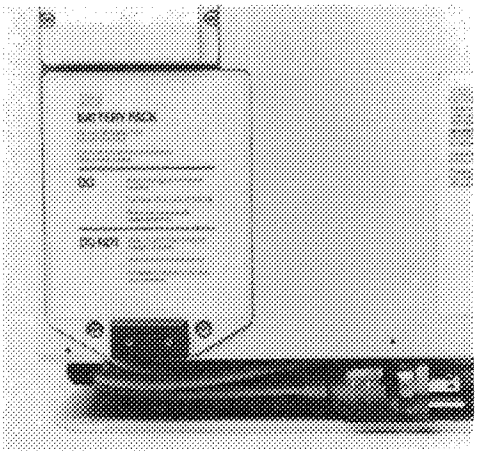
When the monitor displays the message "**LOW BATTERY**", the instrument must be plugged into AC power to ensure proper operation. Fully charged batteries will keep 80% of their charge for several weeks, with the instrument turned off and not plugged into AC.

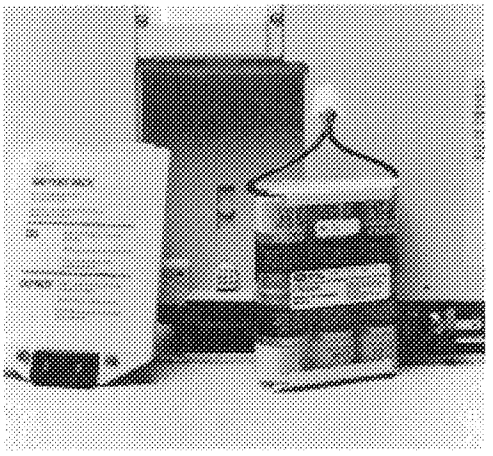
Avoid periodic deep discharge cycling. A battery left uncharged for excessive periods (4 to 6 months) may become damaged and require replacement.

5. CHANGING THE BATTERY PACK

1. Stand the instrument vertically on end. (So that it rests on the cord storage area.)
2. Open the battery compartment door by removing the two screws at the bottom of the door on either side of the rubber support foot.
3. Remove the old battery pack by "pinching" the lever on the white connector that attaches the battery pack to the unit.
4. Replace with a new pack and close the compartment door, ensuring that no wires are crimped or pinched by the door.
5. Check the date and time. Reset, if necessary.

   If the battery has been removed from the unit for longer than 10 minutes, a waiting period of 1 hour is required after a new battery is installed before setting date and time.





6. CLEANING THE PD 1200

Periodic cleaning of the PD 1200 will help keep the unit in top operating condition. It will also provide an opportunity for you to check for cracks in the case and for general wear and tear that may lead to later problems.

- Use a damp cloth (dampen with soap and water only) to clean the outer case and cables.

> *Do not use alcohol, cleaning fluids, or solvents to clean plastic parts.*

- Dry the cleaned areas with a clean, dry, lint-free cloth. Be sure no water drops remain.

- Wipe the surface of nameplates and labels with a clean, dry cloth so that all information is clearly visible.

> *Do not wipe over the surface of nameplates or labels with abrasive cleaners or cloths. This will eventually wear away the information.*

- When replacing modules within the PD 1200, it is recommended to check carefully for any foreign matter that may have fallen into the unit. If necessary, use a low-powered vacuum cleaner to clean the interior before reassembling the unit.

> *Whenever the PD 1200 unit is open, be sure to observe all electrostatic discharge (ESD) precautions. Refer to Section IX, Disassembly Procedures for complete instructions on opening and working within the unit.*

V

TROUBLESHOOTING GUIDES

The guides presented in this section are separated into two parts:

- Operational guides - for use by non-technical personnel during PD 1200 operations. This section answers many of the common problems or questions that arise during operation.
- Technical guides - for use by hospital engineering staff. This section is designed to help isolate problems with the PD 1200's functionality.

Operational Troubleshooting Guide V-3
1. Monitor V-4
2. Recorder V-6
3. Noninvasive Pacing V-7
4. Pacing V-8
5. Defibrillator V-9

Technical Troubleshooting Guide V-11
1. Power-Up Sequence Test V-12
2. System Will Not Run V-13
3. No Response to User Controls V-14
4. Charger V-16
5. Power Supply V-18
6. Power Supply Control V-19
7. Display V-21
8. CPU V-23
9. Defibrillator V-25
10. Pacer V-28
11. ECG V-29
12. Recorder V-31

Error Codes V-32

Extended Diagnostics V-33

Troubleshooting Guide

for

PD 1200

Operational Use

This brief checklist is intended for non-technical personnel.

If trouble persists after consulting this guide, call your Biomedical Engineering department or ZMI Service Operations. A more technical troubleshooting guide is found in the *PD 1200 Service Manual.*

MONITOR

Symptom	Recommended Action
1. No battery charging light when plugged into wall outlet.	1.0 Check red circuit breakers on rear panel (push in). 1.1 Check that battery connection is secure. 1.2 Use another A/C wall outlet.
2. Unit does not turn on. (No 3 audible beeps).	2.0 Check red circuit breakers on rear panel (push in). 2.1 Check that battery connection is secure. 2.2 Check that power cord is plugged into wall outlet.
3. Unit turns on with 3 beeps, but no display on monitor.	3.0 Check red circuit breakers on rear panel (push in). 3.1 Press SYNC button, if green indicator in button comes on - call for service. 3.2 Have battery checked.
4. If any Error message appears on monitor display.	4.0 Call for Service.
5. Date/time message displayed on monitor when turning on unit.	5.0 Reset all values by first incrementing through all values, then set to correct value, i.e., day 1-31, then set to correct day.
6. Set clock is annotated on recorder chart paper.	6.0 Perform step 5.0.
7. ECG LEAD OFF message displayed on monitor.	7.0 Check that the ECG cable is connected to patient and instrument. 7.1 Check that ECG electrodes are not dry. 7.2 Replace ECG cable.
8. Noisy ECG display when using paddles as ECG source.	8.0 Ensure PADDLES is selected. 8.1 Clean paddle surface. 8.2 Check cable(s) for wear.

Monitor, continued

Symptom	Recommended Action
9. Poor ECG signal level, calibration pulse normal (10mm @ 1 mV.)	9.0 Set "size" to x2. 9.1 Change to another lead - I, II, III, Electrodes or Paddles. 9.2 Ensure ECG electrodes are not dried out and are making good contact. 9.3 Install new electrodes using different placement.
10. NO SYSTOLE SOUND (beat detection).	10.0 Increase beeper volume at front handle. 10.1 Change ECG lead selection. 10.2 Alter ECG electrode placement.
11. Heart rate and flashing heart are not being displayed on monitor.	11.0 Change ECG lead selection. 11.1 Alter ECG electrode placement. 11.2 Patient heart rate less than 20 BPM.
12. No SYNC MARKER displayed on ECG SIGNAL ON MONITOR, or intermittently displayed on R wave.	12.0 Ensure "SYNC" switch green light is lit (SYNC ON). 12.1 Change ECG lead selection. 12.2 Alter ECG electrode placement.
13. "LOW BATTERY" message displayed while plugged in A/C wall outlet.	13.0 Check circuit breakers on rear panel (push in). 13.1 Try another wall plug. 13.2 Check that wall plugs are not controlled by a wall switch.

RECORDER

Symptom	Recommended Action
14. No paper displayed on monitor.	14.0 Recorder out of paper. 14.1 Wrong type of paper used. 14.2 Recorder needs adjustment.
15. Paper won't feed into recorder.	15.0 Ensure green indicator light in START/STOP switch is lit. 15.1 Wait ten seconds after first failed attempt to reload. 15.2 Check to see if paper is jammed on feed roller. (see Operator's Guide Rev B).
16. Recorder makes a stuttering sound when activated.	16.0 Check paper path of recorder. 16.1 Check paper feed roller for paper jam.
17. "SYNC" marker (-) not annotating at top edge of paper.	17.0 Ensure "SYNC" switch green indicator is lit. 17.1 Ensure high intensity dot or line is displayed on ECG signal on monitor. 17.2 Change ECG lead selection. 17.3 Paper too narrow. It should be 50mm wide.
18. Light or poor quality tracings/annotations on paper.	18.0 Ensure correct paper is in use. 18.1 Ensure paper is installed thermal side down into lower slot of recorder. 18.2 Recorder print head requires cleaning by trained personnel.

NON-INVASIVE PACING

WARNING: Be sure that pacer output current (mA) is set to **0 mA** when connecting and disconnecting a patient from the PD 1200.

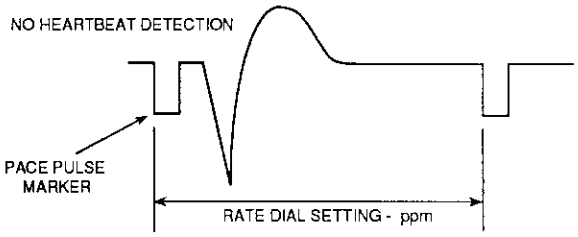
Symptom	Recommended Action
19. Pacer LEADS OFF message is displayed on monitor.	19.0 Ensure pacing electrodes or multi-function electrodes are connected to appropriate cables. 19.1 Ensure electrodes are not dry. *Do not use ECG or defibrillator gel.* Replace electrode if necessary. 19.2 Ensure good electrode-to-patient contact - no buckling or falling off. **CAUTION!** *Turn OUTPUTmA to "0" while checking.* 19.3 Check integrity of pacing cables. For multi-function cable - plug into load test connector on front handle. "Pacer Lead Off" should disappear. For standard Pace Cable - connect to Zoll NTP 4450 Pace Check - "Pacer Lead Off" should disappear. 19.4 Replace pace cables.
20. No stimulus marker ⊓⊔ present on ECG trace displayed on monitor.	20.0 Ensure PD 1200 is in Pacer ON position. 20.1 Ensure Pacing Rate (ppm) dial is set greater than patient rate.
21. No ventricular capture beat after stimulus marker on ECG monitor display.	21.0 Increase output current level. 21.1 Change ECG Lead select. 21.2 Review pacing electrode placement. 21.3 Verify that pacemaker is delivering the proper current using the ZOLL Pace Check tester or have Biomedical Engineering check output. 21.4 Check for pulse of patient.

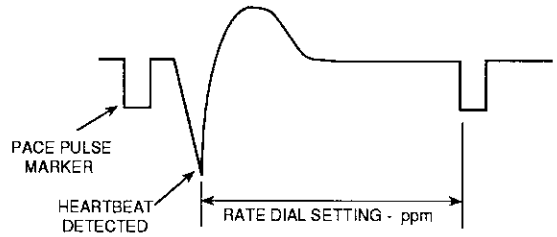
PACING

Symptom	Recommended Action
22. Patient on "Standby" pacing gets paced intermittently. NOTE: If ECG lead wire comes off, pacer will automatically pace asynchronously.	22.0 Ensure good ECG electrode and placement. 22.1 Check ECG cable for wear and tear or bad connections. 22.2 Patient R wave-to-R wave interval varying. Pace rate close to patient rate.
23. Displayed paced heart rate is less than the Pacing Rate (ppm) setting.	23.0 Normal response.*
24. Heart rate is **0** with proper pacing capture displayed on ECG trace.	24.0 Change ECG Lead Selection. 24.1 Some patients' paced beats will not be counted. 24.2 Check patient's pulse, remembering check #23.
25. Bedside/Central Station monitor display becomes erratic when pacing.	25.0 Patients cannot be "double patch" ECG monitored while pacing. Use Zoll adapter cable NTP-3007.

*** Pace Pulse Operation:** When you set the PD 1200 to a pacing rate - for example, 60 ppm, it will generate a pace pulse per second (60 pulses per minute). This is controlled by a timer within the PD 1200 which resets each time a pulse is generated.

The timer is also reset each time a heartbeat is detected. If the patient's heartbeat is detected by the PD 1200 in the middle of a pace period (for example,.2 seconds after the last pulse), the PD 1200 will restart the pace period. The next pace pulse will occur 1.2 seconds after the previous pulse, because of the heartbeat detection. Therefore, if the heartbeat of the patient is detected, it is normal to have fewer pace pulses per minute than the RATE dial setting.





DEFIBRILLATOR

Symptom	Recommended Action
26. PADDLE FAULT message on monitor.	26.0 Remove and reinstall paddle cable plug into receptacle on front of PD 1200.
27. Noisy ECG signal when paddles selected as ECG input.	27.0 Press and firmly hold paddles against patient. 27.1 Clean paddle surface. 27.2 Check cables for wear.
28. ANY ERROR displayed.	28.0 Have instrument serviced promptly by trained personnel.
29. Defibrillator won't charge (energy level does not increment on display).	29.0 Check that discharge switches in Paddles or in multi-function cable are not stuck in. 29.1 Have battery checked.
30. Charge time to 360J exceeds 10 seconds.	30.0 Normal, if operating in low battery condition. 30.1 Charge battery. 30.2 Have device serviced.
31. Energy will not discharge when both discharge buttons are pressed.	31.0 Device is in "SYNC" mode and no QRS complex is detected. 31.1 Sixty (60) seconds had elapsed after initial charge. Energy was internally discharged. 31.2 Energy internally discharged because energy selector dial was moved to another energy selection. 31.3 Wait for Charged and Ready tone.
32. Displayed energy value does not match energy selected.	32.0 Defibrillator is out of adjustment. Have it serviced promptly.
33. Unable to "SYNC" cardioversion discharge.	33.0 Ensure green indicator located in SYNC switch is lit. 33.1 Check for "SYNC" marker (high intensity dot or line on R wave). If not present, change ECG lead selection. 33.2 Alter ECG lead wire placement.

Defibrillator, continued

Symptom	Recommended Action
34. No apparent energy delivery to patient.	34.0 Perform defibrillator self test as described in Operator's Guide Rev A- page 34 or Operator's Guide Rev B- page 40,48. 34.1 If test fails, have the unit serviced promptly. 34.2 If Defib/Pace electrodes are used, ensure proper placement and contact.
35. Unable to do Cardioversions (energy delivery evidenced).	35.0 If Defib/Pace electrodes are used, ensure proper placement/orientation over heart.

Technical Troubleshooting Guide for the PD 1200

These guides are designed to isolate problems to a module level. Once the faulty module has been identified, it should be removed and replaced with a factory-calibrated replacement module. For assistance in the use of these guides, contact the Service Dept., ZMI Corporation, at 1-800-348-9011 or (617) 933-9150.

Whatever the symptoms of the problem, we recommend the following checks FIRST:

- Check the battery level. A weak battery may cause symptoms of failure. Follow the checkout procedure described on page V-33. You do not need to open the unit.
- Check the four Power Supply voltages according to the procedure in the **Power Supply** troubleshooting guide, page V-18. All of the functions of this instrument are dependent on the Power Supply outputs.
- Perform the Power-Up Sequence Test described on the next page. It is designed to isolate problem areas.

Notes

- Observe anti-static precautions whenever the unit is open.
- Make sure all connectors are seated properly.
- All voltages called out in the troubleshooting guides are with respect to system ground, unless specifically noted.

1. POWER-UP SEQUENCE

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for at least 3 seconds.

To perform the **Power-Up Sequence Test**, simply turn the PD 1200 ON and watch for the following sounds, lights, and messages.

LISTEN and LOOK for . . .	If you don't HEAR or SEE . . .
• Two (2) audible clicks (Power Supply relays closing.)	If no sound is heard, go to **System Will Not Run** troubleshooting guide.
• Four (4) LEDs blink - SYNC button LED - ALARM ON button LED - START/STOP button LED - CHARGE LED on the Apex defib paddle • Three (3) audible beeps are sounded. The System Diagnostic is in progress.	If the LEDs do not blink and no beeps are heard, go to the **CPU** troubleshooting guide.
• READY, then MONITOR ON messages appear on the display. The system is ready.	If the messages do not appear, go to the **Display** troubleshooting guide.

If the PD 1200 does execute a complete **Power-Up Sequence Test**, proceed to the troubleshooting guide that corresponds to the original problem.

2. SYSTEM WILL NOT RUN

> To remove the battery or open the unit, refer to the Disassembly Procedure in Section IX of this manual.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for 3 seconds, then ON.

Symptom	Check:
Unit will not power up -or- Unit shuts down immediately after power up.	1. The battery voltage must be at least 11 volts. If the battery voltage is low despite the unit being plugged in, see the **Charger** troubleshooting guide. 2. Check that all internal cables are connected and seated correctly. 3. If the unit is still unresponsive, check the output voltages of the Power Supply board. If one or more of these is not correct, see the **Power Supply** troubleshooting guide. 4. See the **Power Supply Control** troubleshooting guide.

3. NO RESPONSE TO USER CONTROLS

Refer to the schematics in Section VII of this manual.

To open the unit, refer to the Disassembly Procedure in Section IX.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for 3 seconds, then ON.

Symptom	Check:
No response from the START/STOP or MARK buttons.	**1.** If only one of the buttons will start the Recorder, the failing button's switch assembly or cable routing is the problem. **2.** If neither of the buttons will start the Recorder, charge the defibrillator to 2 Joules and discharge it with the paddles placed in the side pockets of the unit. • If the Recorder runs after the discharge, the problem is in the switch assembly and/or cable routing. • If the Recorder does not run, see the **Recorder** troubleshooting guide.
No response from the LEAD button.	**1.** If both the numerical indicators (.5x, 1x, 2x) and the ECG display do not respond, the problem is in the button's switch assembly or cable routing. **2.** If the numerical indicators respond, but the ECG display does not, check the CPU signals LeadSel0, 1, 2, and 3. If they are active when the LEAD button is pressed, then the problem is on the ECG board.

Continued on next page

No Response to User Controls, continued

Symptom	Check:
No response from the FREEZE, SYNC, ALARM ON, ALARM SET, or UP and DOWN ARROW buttons.	1. If any of these buttons do not respond, the problem is in the button's switch assembly or cable routing.
No response from the Pacer RATE and/or OUTPUT knobs.	1. Check for the following voltages on J69 of the CPU board: • 2.5V on pins 1 and 3 • 0V on pins 5, 6, and 7 • pin 4 voltage controlled by the RATE knob • pin 2 voltage controlled by the OUTPUT knob If these voltages are present, the CPU board is most likely the problem.
No response from the ECG SIZE button.	1. Apply an ECG signal to the unit. If the size number (.5, 1, or 2) changes each time the button is pressed but the waveform remains unchanged, check the CPU signals S0P, S1P, and S2P. If they respond when the SIZE button is pressed, the ECG board should be replaced.

4. CHARGER

This guide is intended to be used in conjunction with the Functional Description of the Charger in Section VI and the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

At the module level, the Charger circuit is basically an "input-output" component. The input is a 25 to 30 peak sinewave from the secondary of the line transformer. With this input present, the Charger circuit will produce approximately 14 volts DC at P2, which is connected across the battery.

Preliminary set-up:

1. The unit has been plugged in and in the OFF position for at least one hour.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.

Symptom	Check:
The battery will not charge.	**1.** Be certain that line voltage is present at the AC wall outlet you are using. **2.** With an oscilloscope, measure the voltage at P1 pins 1 and 2. There should be a 25 to 30 volt sinewave on each pin. If there is no sinewave, the line transformer needs service. **3.** Measure the Charger output voltage across P2 pins 1 and 2 on the Charger board. It should be between 14.0 and 14.5 volts. If it is, the battery may need replacement. If it is not, the Charger module needs replacement.

Continued on next page

Charger, continued

Symptom	Check:
Charger output is correct, but the battery will not hold a charge.	**1.** Remove the battery and measure the voltage on it. If it is less than 14 volts after an hour of charge time, the battery most likely needs to be replaced. **2.** If both the Charger and battery voltages are in spec, then either the Defib, Pacer, or Power Supply has malfunctioned and is applying a constant drain on the battery. Reconnect the battery. Disconnect P81 and P82 from the Defib board. If the unit will function in the MONITOR ON position for two hours, the Defib board needs to be replaced. **3.** If the unit won't function for two hours with the Defib disconnected, disconnect P3 from the Power Supply board and charge the unit for another hour. Then reconnect P3 on the Power Supply and remove P1 from the Pacer board. If the unit will then function in the MONITOR ON position for two hours, the Pacer board needs to be replaced. **4.** If the unit still won't function for two hours, the Power Supply needs to be replaced.
Charger and battery are functioning, but the front panel indicator does not light.	**1.** The signal that lights the indicator is a train of AC pulses derived from the switching output. It follows this path from the Charger circuit to the front-panel: • leaves the Charger module on P16-1 • enters the Power Supply module on P9-1 • leaves the Power Supply module on J10-21 • enters the CPU module on J60-21 • leaves the CPU module on J61-22 • enters the main switch assembly and is passed on to the front-panel circuit board on J22-1 **2.** If the signal can be traced to the front panel circuit board, the board should be replaced. If the signal is lost along the path, the module that it enters but doesn't leave needs replacement.

5. POWER SUPPLY

> This guide is intended to be used in conjunction with the Functional Description of the Power Supply in Section VI and the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

At the module level, the Power Supply circuit is basically an "input-output" component. There are three input voltages that are necessary to produce the four output voltages.

Preliminary set-up:

1. The unit has been plugged in and in the OFF position for at least an hour.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched ON.

Symptom	Check:
One or more output voltage(s) is dead or out of spec.	1. Measure at least 14 volts DC at TP6 on the Power Supply board. If this voltage is not correct, the battery is not properly charged. See the **Charger** troubleshooting guide. 2. Measure the voltages between GND and P12 pins 5 and 6: • If both of these voltages are greater than 12 volts DC, the Power Supply module needs to be replaced. • If either of these voltages are less than 12 volts DC, see the **Power Supply Control Board** troubleshooting guide. 3. Remove all connectors from the Power Supply except the 26 pin ribbon cable to the CPU board and P1 from the Charger board. • If the voltage(s) do return, one of the disconnected boards is the problem. Reconnect the cables one at a time until the problem recurs to determine which board is loading the supply down. • If the voltage(s) do not return, the Power Supply module needs replacement.

6. POWER SUPPLY CONTROL

There is no Functional Description to supplement this section. The status of this circuit can be determine by measuring four voltages. Refer to the schematics in Section VII of this manual.

The Power Supply Control board is part of the Power Supply module, but can be replaced separately if it malfunctions. See the Disassembly Procedure in Section IX.

At the module level, the Power Supply Control circuit is basically an "input-output" component. There are two input voltages that are necessary to produce the two output signals.

Preliminary set-up:

1. The unit has been plugged in and in the OFF position for at least an hour.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched ON.

Symptom	Check:
The unit will not turn ON.	**1.** Measure at least 14 volts DC at P1-1 on the Power Supply Control board. If this voltage is correct, go to step 4. **2.** Measure the voltage at P2-2 on the Charger board. If it is less than 14 volts, either the battery or the Charger circuit has malfunctioned. See *The battery will not charge* in the **Charger** troubleshooting guide. **3.** If the voltage measured in step 2 is correct, the Power Supply module needs replacement. **4.** The voltage on P1-2 on the Power Supply Control board should go to zero volts when the front panel rotary switch is placed in any position except OFF. If this voltage is correct, go to step 7.

Continued on next page

Power Supply Control Board, continued

Symptom	Check:
The unit will not turn ON. (continued)	5. The signal to turn the unit on and off originates at the front panel rotary switch and follows this path to the Power Supply Control board: • leaves the front panel switch assembly on pin 24 on the main connector • enters the CPU module on J61-24 • leaves the CPU module on J60-20 • enters the Power Supply module on J10-20 • enters the Power Supply Control board on P1-2 6. If the signal can be traced to the Power Supply Control board, the board should be replaced. If the signal is lost along the path, the module that it enters but doesn't leave needs replacement. 7. Measure the voltages at P1-5 and P1-6 on the Power Supply Control board. These points should measure at least 12 volts DC. If either voltage is incorrect, the Power Supply Control board needs to be replaced. If they are both correct, see the **Power Supply** troubleshooting guide.

7. DISPLAY

Refer to the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for 3 seconds, then ON.

Symptom	Check:
No display.	1. Press the ALARM ON button. • If the LED in the button does not light, see the **CPU** troubleshooting guide. Go to *Four LEDs do not blink....* • If the LED does light, the CRT tube, CRT Control board, or High Voltage Power Supply board needs service.
"**ERROR**" is displayed.	1. Press the ALARM ON button. • If the LED in the button does not light, see the **CPU** troubleshooting guide. Go to *Four LEDs do not blink....* • If the LED does light, the problem is in the CPU-to-CRT communication link. Either open the case or remove the Recorder. Make sure that the 10-pin ribbon cable from the CPU is firmly seated in its connector on the CRT board. 2. The voltage on U1 pin 11 on the CPU board should be switching between 0 and 5 volts. If it is not, the problem is on the CPU board. 3. The voltage on U2 pin 10 on the CRT board should be switching between 0 and 5 volts. • If it is not, the problem is in the 10-pin ribbon cable or on the CPU board. • If it is oscillating or switching, the problem is on the CRT board.

Continued on next page

Display, continued

Symptom	Check:
The display blinks on and off at four second intervals.	1. The problem is in the CRT-to-CPU communication link. Make sure that the 10-pin ribbon cable from the CPU is firmly seated in its connector on the CRT board. 2. The voltage on U2 pin 11 on the CRT board should be switching between 0 and 5 volts. If it is, the problem is on the CPU board or in the 10-pin ribbon cable. If it is not, the problem is on the CRT board. 3. The voltage on U1 pin 10 on the CPU board should be switching between 0 and 5 volts. • If it is not, the problem is in the 10-pin ribbon cable. • If it is oscillating, the problem is on the CRT board.
The ECG trace is noisy.	1. See the **ECG** troubleshooting guide.

8. CPU

This guide is intended to be used in conjunction with the Functional Description of the CPU in Section VI and the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

The CPU controls many instrument functions and coordinates the interaction of the individual modules. However, most CPU failures can be detected during the **Power-Up Sequence Test**.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for 3 seconds, then ON.

Symptom	Check:
The four (4) LEDs do not blink on and off during Power-Up.	1. Disconnect the: • Pacer from the Power Supply and the CPU. • Defib from the Power Supply (J81 and J82). • ECG from the CPU. • Upper Housing from the Power Supply. • Recorder from the Power Supply. 2. Turn the unit off for at least three seconds, then turn it on. • If the four LEDs blink on and off during Power-Up, reconnect one of the cables from step 1 and cycle the unit off and on again. Repeat this step for each cable until the faulty board is determined. • If the four LEDs do not blink, the CPU board needs service.

Continued on next page

CPU, continued

Symptom	Check:
Three (3) audible beeps do not occur during Power-Up.	1. If the unit functions correctly except for the three beeps, the beeper may be tested by applying a QRS waveform to the ECG input. A beep should be heard for each QRS waveform displayed on the monitor. 2. If the unit does not function correctly, disconnect the: • Pacer from the Power Supply and the CPU. • Defib from the Power Supply (J81 & J82). • ECG from the CPU. • Upper Housing from the Power Supply. • Recorder from the Power Supply. 3. Turn the unit off for at least three seconds, then turn it on. • If the three beeps are sounded during Power-Up, reconnect one of the cables from step 1 and cycle the unit off and on again. Repeat this step for each cable until the faulty board is determined. • If the three beeps do not sound , the CPU board needs service.

9. DEFIBRILLATOR

> This guide is intended to be used in conjunction with the Functional Description of the Defibrillator in Section VI and the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

Defibrillator problems are caused by a malfunction in the paddles, the CPU, or the defibrillator module itself. The tests described below are designed to determine which of these three modules needs replacement.

Preliminary set-up:

1. The battery is charged and the unit is plugged in to an AC outlet.
2. A set of paddles is connected to the unit.
3. The front panel rotary switch is set to DEFIB ON 2 JOULES.
4. A Defib Tester is present.

Symptom	Check:
Any type of defibrillator problem.	1. Check fuse F1 on the defibrillator board. 2. Try a different set of paddles or check the existing paddles as follows: • Try charging the unit using the Apex paddle CHARGE button. If the unit charges, the problem is in the front panel CHARGE button assembly. • Measure continuity between pins 4 and 10 on the paddles when both DISCHARGE button are pressed. If these pins are always shorted together, the paddles are defective and will prevent the defibrillator from charging. • Measure continuity between pins 7 and 8 on the paddles when the Apex CHARGE button is pressed.
ERROR 44 is displayed.	1. Check the fuse (F1) on the defibrillator board. If the fuse is bad, replace it and try to charge the unit. If the fuse is good, the defibrillator module needs replacement.

Continued on next page

Defibrillator, continued

Symptom	Check:
The unit will not charge.	**1.** Measure the voltage at TP9. The voltage should be less than 0.5 volts. If it is, go on to step 2. If the voltage at TP9 is greater than 0.5 volts, measure the voltage at the junction of J80-10 and R46. If it's greater than 4.5 volts, the defibrillator module needs replacement. If it's less than 4.5 volts, the CPU module needs replacement. **2.** Press the front panel CHARGE button. The voltage at TP9 should go to greater than 4.5 volts. If it does, go to step 3. If the voltage at TP9 does not go higher than 4.5 volts, measure the VCAP voltage at U2-14. If it is zero volts, the CPU module needs replacement. If it is not zero, the defibrillator module needs replacement. **3.** With an oscilloscope, monitor U4-3. When the CHARGE button is pressed, a 16KHz squarewave should appear. If it does, the defibrillator module needs replacement. If it does not appear, the CPU module needs replacement.
The unit will not charge to a selected energy level.	**1.** If internal paddles are being used, maximum energy is 50 joules. **2.** Press the CHARGE button and measure the VCAP voltage at U2-14. If this voltage exceeds 5 volts, the CPU module needs replacement. If the VCAP voltage does not exceed 5 volts, the defibrillator module needs replacement.

Continued on next page

Defibrillator, continued

Symptom	Check:
The unit will charge but will not discharge.	**1.** Verify that the paddles being used are functioning properly. See above *Any type of defibrillator problem.* **2.** Press the CHARGE button. Measure the voltage at the junction of J80-20 and R14.as the DISCHARGE buttons are pressed. If it goes to 5 volts, the defibrillator module needs replacement. If it does not go to 5 volts, the CPU module needs replacement. **3.** If the unit discharges with paddles but not with the multi-function cable (MFC), the problem is with the CPU board or the Pacer board. In order to discharge, a load of 50 W must be connected to the MFC. Use the test jack. Check that the resistance from pins 1-4 is 50 W. A message "Electrodes OFF" indicates a fault in the CPU board or Pacer wiring. Failure to get this message when the cable is open indicates a fault in the Pacer board.

10. PACER

This guide is intended to be used in conjunction with the Functional Description of the Pacer in Section VI and the schematics in Section VII. To open the unit, refer to the Disassembly Procedure in Section IX.

At the module level, the Pacer circuit is basically an "input-output" component. The inputs are four signals from the CPU module. The output is a pulse of rate and magnitude determined by the front panel RATE and OUTPUTmA knobs.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. Attach a pacer cable to the PD 1200. Use a pair of electrodes with gel sides together, or insert a 1k 5w resistor to the pacer output or to the end of the pace cable.
5. The OUTPUT mA knob is set to 40 and the RATE ppm knob is set to 60.

Symptom	Check:
No Pacer output. (operational checks)	1. Try another set of Pacer electrodes and/or pacer cable, if available. 2. Ensure proper contact between the Pacer electrodes and the patient.
If still no pacer output, continue testing:	3. These four signals must be present on P3 of the Pacer board: • P3-1: a 25KHz burst pulse • P3-2: inversion of P3-1 • P3-4: +5 volts • P3-10: a voltage greater than .3V that varies with the OUTPUTmA knob If these signals are present, the Pacer module needs replacement. If one or more of these signals is not present, the CPU module needs replacement.

11. ECG

Refer to the schematics in Section VII of this manual. To open the unit, refer to the Disassembly Procedure in Section IX.

Preliminary set-up:

1. Unit is running and plugged in.
2. A set of ECG leads are connected to the unit.

Symptom	Check:
The message, ECG LEADS OFF, will not display or is always displayed.	1. If available, try another set of cables. 2. Check continuity from each lead to the corresponding pin on J10 on the ECG board as follows: RA - pin 1 LL - pin 3 LA - pin 5 3. Disconnect the ECG to CPU ribbon cable. If the display remains incorrect, the problem is on the CPU board; otherwise the problem is on the ECG board.
The ECG baseline is not centered on the monitor.	1. Disconnect an ECG lead. If the trace comes to center, the ECG board is most likely the problem. 2. With zero ECG input, the voltage at RP37-15 on the CPU board should be zero. • If it is zero, the offset problem is on the CPU. • *If it is not zero, the problem is on the ECG board.*
The ECG gain is incorrect.	1. Perform the ECG Tests in the Checkout Procedure, Section III-6. If the unit performs the test correctly, the problem is most likely on the ECG board.

Continued on next page

ECG, continued

Symptom	Check:
Bandwidth is less than 40 Hz, or more than .5 Hz.	1. Perform the ECG Tests in the Checkout Procedure, Section III-6. If the unit performs the test correctly, the problem is most likely on the ECG board.
No ECG from paddles, but ECG from cables is OK.	1. The resistance between the cathodes of CR1 and CR2 on the ECG board should be from 160 to 200 KΩ. If this resistance is correct, the paddles may need service.
No ECG from cable, but ECG from paddles is OK.	1. Check continuity from each lead to the corresponding pin on J10 on the ECG board as follows: RA/pin 1 LL/pin 3 LA/pin 5
The ECG baseline is noisy.	1. Disconnect a lead. If the noise remains, the problem is on the CRT board. 2. Check continuity from each lead to the corresponding pin on J10 on the ECG board as follows: RA - pin 1 LL - pin 3 LA - pin 5 3. Short the leads together. If the noise ceases, the ECG cable requires replacement. 4. Measure the voltage at RP37-15 on the CPU board. • If the noise is present, the problem is on the ECG board • If it is not, the problem is on the CPU board. 5. The resistance between the cathodes of CR1 and CR2 on the ECG board should be from 160 to 200 KΩ.

Continued on next page

ECG, continued

Symptom	Check:
No ECG tone.	1. Listen for three beeps from the unit during start-up. • If the three beeps do not occur upon start-up, follow the procedure outlined in the **Power-Up Sequence** troubleshooting guide. • If three beeps occur, the problem is most likely on the ECG board. 2. The voltage at pins 1 and 2 of J62 on the CPU should oscillate at each QRS pulse. • Absence of an oscillation at pin 1 indicates a CPU failure. • Absence of an oscillation at pin 2 indicates a ECG failure.

12. RECORDER

The Recorder is basically a separate instrument that receives only power and information inputs from the PD 1200. To access the Recorder, refer to the Disassembly Procedure in Section IX of this manual.

Preliminary set-up:

1. The unit is plugged in.
2. The rear panel Circuit Breakers are not tripped (not extending outward).
3. A battery is in place and charged.
4. The unit is switched OFF for 3 seconds, then ON.

Symptom	Check:
Recorder will not run when the START/STOP or MARK buttons are pushed.	**1.** If only one of the buttons will start the Recorder, the problem is in the failing button's switch assembly or cable-routing. **2.** If neither button will start the Recorder, charge the defibrillator to 2 Joules and discharge it with the paddles placed in the side pockets of the unit. • If the Recorder runs, both the START/STOP and MARK buttons have switch assembly or cable-routing problems. • If the Recorder does not run after discharge, the problem is most likely in the Recorder itself.
ECG gain is incorrect.	See the **ECG** troubleshooting guide.

NOTE: If an inoperative Recorder is accompanied by a monitor display of **ERROR 51**, the problem is most likely in the +18 volt power supply. See the **Power Supply** troubleshooting guide.

13. ERROR CODES

The internal diagnostics of the PD 1200 can detect a number of failures and identify the faulty circuit. When one of these failures occurs, the unit will display the word **ERROR** followed by a number which corresponds to the failure.

Error #	Description	Type of Problem
none	See the **Display** troubleshooting guide.	
1	The watchdog timer selftest failed.	CPU
3	CPU ROM failed its checksum test.	CPU
10	Error in the Real Time Clock update.	CPU
33	CRT ROM failed its checksum test.	CRT
34	Character ROM failed its checksum test.	CRT
35	CRT RAM failed its read/write test.	CRT
41	Defib cap voltage is too high to allow a discharge.	Defibrillator
42	Defib cap voltage has exceeded its absolute maximum.	Defibrillator
43	The logic on the Defib board is preventing a charge.	Defibrillator
44	Defib cap or charge circuit is trying to charge but is failing.	Defibrillator
45	Maximum allowable charge time has been exceeded without reaching target energy.	Defibrillator
46	Defib cap is stuck at a non-zero voltage.	Defibrillator
47	Defib cap voltage has overshot the target level and is being bled down.	Defibrillator
50	Battery voltage has dropped below the minimum operating level. Shutdown is imminent.	Power Supply
51	-12V and/or +18V supply(s) has exceeded its limits.	Power Supply
52	+2.5V supply has exceeded its limits.	Power Supply
53	+10V supply has exceeded its limits.	Power Supply
70	Protect Relay failure.	ECG

14. EXTENDED DIAGNOSTICS MODE

All PD 1200 units perform a thorough self-test upon power-up and continue to monitor critical components throughout normal operation. In addition, all units shipped after October 1989 offer an EXTENDED DIAGNOSTICS MODE.

In the extended mode, **the unit remains fully operational,** but presents information on the monitor which can be used to calibrate and otherwise verify proper operation. The type of information presented will vary depending on the setting of the SELECTOR SWITCH:

MONITOR ON
PACER ON
DEFIB ON

ENTERING EXTENDED DIAGNOSTICS MODE

- Hold the SYNC button down for at least three (3) seconds while powering on the unit. The PD 1200 will acknowledge EXTENDED DIAGNOSTICS MODE by beeping an additional two times after the normal three "power-on" beeps.

BATTERY CHARGER OPERATIONAL CHECK
(MONITOR ON)

With the SELECTOR SWITCH set to MONITOR ON, battery voltage is displayed on the monitor (e.g., "125V" for 12.5 volts).

- Unplug the PD 1200 from the wall. Battery voltage will slowly drop and settle between 11.0 and 12.5 volts (110V - 125V).
- Plug the unit back into the AC wall outlet. The battery voltage display will begin to climb, eventually settling between 13.5 and 14.2 volts (135V - 142V). This indicates proper charger operation.

PACE RATE CHECK
(PACER ON)

In PACER ON mode, the measured heart rate in the upper right corner of the monitor is replaced with the reading from the RATE knob. The number is clearly marked "ppm" and must match (within 5%) the printed value selected by the rate knob.

- Turn the rate knob and verify that the display changes.
- Turn the knob to 100. The monitor should read between 95 ppm and 105 ppm.

Note: The unit is still detecting heart beats (if connected to a patient or ECG simulator) as evidenced by the flashing heart and tone. Also, the actual measured heart rate will appear on the strip chart annotation.

PACE OUTPUT CHECK
(PACER ON)

The number on the OUTPUT dial and the mA display at the lower right corner of the monitor must be within +/- 7 mA of each other at all settings.

- Turn the output knob to 0. Verify that the display reads 0 mA.
- Turn the knob to 70. Allowable display range = 63 to 77 mA.
- Turn the knob to 140. Allowable display range = 133 to 140 mA.

DEFIBRILLATOR CHARGE TIME
(DEFIB ON)

With the unit charged and ready to fire, the display indicates the time (to the nearest half second) that it took to charge. Like the battery voltage display, there is an implied decimal point (i.e., 75S means 7.5 seconds).

Perform this test with the PD 1200 plugged into an AC wall outlet or with a fully charged battery. A depleted battery may extend defibrillator charge time.

- Select 360 joules and charge the defibrillator. When the ready tone sounds, the time should read less that 10 seconds.

  Typically, a PD 1200 with a fully charged battery will take 6.5 to 8.0 seconds (displayed as 65S to 80S) to charge to 360 joules.

Carefully discharge the unit into the paddle wells, or if using the multi-function cable, into the test connector located in the lower left front of the device.

PEAK DELIVERED DEFIBRILLATION CURRENT
(DEFIB ON)

After a discharge into the PD 1200's own self-test circuit, the unit will measure and display a number for the peak current delivered.

- Select 200 joules. Charge and discharge the defibrillator into the paddle wells or multi-function test connector.

  The display should read approximately "100PEAK".

This feature works at all energy levels. Repeat as desired and compare the number displayed to the PEAK value in the table below to determine if the unit is delivering energy within AAMI specifications.

± 15% J

Energy Selected	PEAK	Allowable Range	Approximate Current
2J	10	0 - 18	4.3A
3J	12	0 - 19	5.3A
5J	16	7 - 22	6.8A
7J	19	12 - 24	8.1A
10J	22	17 - 27	9.7A
20J	32	28 - 35	13.7A
30J	39	35 - 42	16.7A
50J	50	46 - 54	21.6A
100J	71	65 - 76	30.6A
150J	87	79 - 93	37.4A
200J	100	92 - 108	43.2A
300J	122	112 - 132	52.9A
360J	134	123 - 144	58.0A

Note: *The PD 1200 self-test circuit should be periodically tested against a calibrated defibrillator tester. Instructions for performing this test are in the Service Manual.*

VI

FUNCTIONAL DESCRIPTIONS

This section describes the basic operation of the circuits and supplements the troubleshooting guides in Section V of this manual.

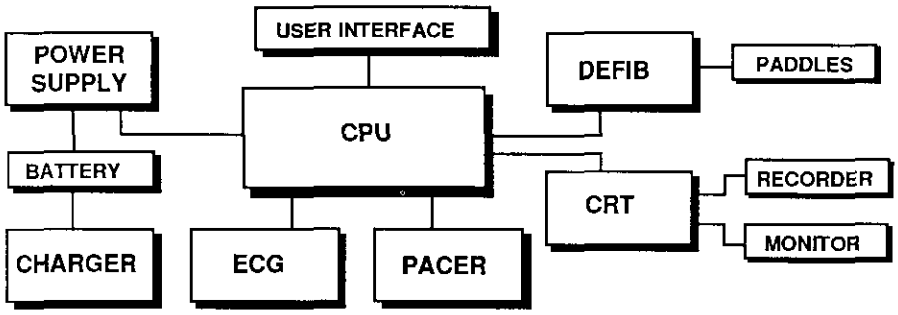
For additional information, refer to the associated schematic(s) found in Section VII.

TABLE OF CONTENTS

1. System VI-2
2. Charger VI-3
3. Power Supply VI-4
4. CPU VI-6
5. Defibrillator VI-9
6. Pacer VI-12
7. ECG VI-13
8. CRT VI-16

1. SYSTEM

The PD 1200 has a modular design philosophy. Each of the major circuits is contained on a separate assembly, which if defective, can be directly exchanged with a factory calibrated replacement.



System Diagram

The seven major circuit assemblies and their functions are:

1. **Charger** - The Charger assembly converts the output of the line transformer into a DC voltage that is applied to the battery. This circuit also provides the signal to light the front panel "Battery Charging" LED.
2. **Power Supply** - The Power Supply assembly provides the system with a number of low voltage supplies. The battery voltage is input via a circuit breaker to this circuit.
3. **CPU** - The CPU handles the primary instrument functions and enables interaction between the operator and overall system. The circuit is designed around a microprocessor, whose functions include pacer pulse generation, patient ECG signal processing, defibrillation charge and discharge control, reading operator controls, and system diagnostics. The interface between the CPU and the rest of the system is simple and direct. Individual cables are devoted to each circuit assembly.
4. **Defibrillator** - The Defibrillator assembly will charge the high voltage capacitor (HVC) to the desired target energy and deliver the waveform shaped HVC energy to the patient connector. The high voltage capacitor circuit controls the shape and delivery of the energy waveform to the paddles.
5. **Pacer** - The Pacer assembly provides patient-isolated pacing pulses. Pulse rate and amplitude are controlled by the CPU in accordance with the settings of the front panel knobs.
6. **ECG** - The ECG assembly receives ECG information from either the three lead input or the Defibrillator patient connector. The ECG signal is then amplified and filtered for display and CPU signal processing for QRS detection.
7. **CRT** - The CRT assembly controls the presentation of ECG data and character data on the CRT monitor and also controls the information presented on the stripchart Recorder.

2. CHARGER

The function of the Charger circuit is to convert the stepped down line voltage from the input transformer into approximately 14 volts DC, which is applied across the battery. The power output of the Charger circuit varies with the demands of the battery.

The major component of the Charger circuit is a Pulse Width Modulator (U201). Its basic function is to drive the gate of a series-pass transistor (Q202). The resulting waveform is filtered by an LC network to produce approximately 14 volts DC at the output connector (P2).

A 30 volt peak sinewave at P1 is full-wave rectified to produce 25 to 30 volts DC at TP1. This biases the AC power sense circuit of Q200 and Q201, which provides VCC to U201-10. A drive pulse is subsequently produced at U201-9, which drives the gate of the series-pass transistor (Q202).

When Q202 is being driven, a 25 to 30 volt waveform is produced at TP4. This waveform is filtered by L200 and C204 . The amplitude of the resulting DC voltage at TP5 is controlled by the resistive divider of R214, R215, and R216.

The key test points when troubleshooting the Charger module are:

a. P1 pins 1 and 2 - a 30 volt peak sinewave on each pin

b. TP1 - 25 to 30 volts DC

c. TP4 - a 25 to 30 volt waveform

d. TP5 - 14 volts DC

3. POWER SUPPLY

The Power Supply circuit converts the battery voltage (RAWBATCB) into four supply voltages: +5V, +10V, +18V and -12V. In addition, RAWBATCB is passed through two relays to provide a switched battery voltage (+12VSW) to the unit.

The voltages referred to below assume that a fully-charged battery is in place. However, the Power Supply is capable of running on a battery voltage of approximately 11 volts.

Inputs

There are three inputs to the Power Supply module:

- RAWBATCB
- 1ST RELAY
- 2ND RELAY

RAWBATCB is the battery voltage, passed through a protective circuit breaker. The 1ST and 2ND RELAY signals are produced by the Power Supply Control board to provide proper sequencing during startup and shutdown procedures.

Outputs

The output voltages produced by the Power Supply can be divided into two groups. The first group, +5V and +18V, start up when the 1ST RELAY signal is sent from the Control board. If either of these supplies is working, RAWBATCB and 1ST RELAY are functioning properly.

The second group of outputs, +10V, -12V, and +12VSW, start up when the 2ND RELAY signal is sent from the Control board. If any of these supplies is working, RAWBATCB and 2ND RELAY are functioning properly.

Output	Use of the Output	Test Point Power Supply Board
+5V	Used to drive the recorder, CRT, CPU, Pacer, ECG Defib (CPU side), and as VCC throughout the unit	CR5 Cathode
+10V	Used for the analog supply for the CPU and ECG boards	C1+
-12V	Supplies the negative supply for the CRT and ECG boards and voltage for the isolated side of the ECG. Also used by the CPU, ECG, and Pacer to generate a negative reference.	R35
+12VSW	Used by all boards and to power the main selector switch.	U6-10
+18V	Used to drive the recorder motor and to boost patient relay transfer time.	TP11
RAWBATCB	Used for the front panel main selector switch and the ON/OFF control board.	CR2 Cathode

Operational State

During normal operation with a fully charged battery and power on the AC line:

- P1-2 (ORN) will be in the range of 13.8 to 14.5 volts DC. Note P1 is located closer to the tie wrap strain relief hole.
- TP9 & TP10 will be > 10 volts DC.
- Q5 TAB will be in the range of 13.8 to 14.5 volts DC.

4. CPU

The CPU board is the central control for the PD1200 instrument. It receives information from the front panel switches and from signals internal to the instrument. After making decisions based on the information received, it controls the operation of functional blocks such as the pacer output, defibrillator output, ECG input, and the CRT display and recorder output board.

The basic hardware functional blocks on the CPU board are as follows:

1. Front panel I/O control
2. Microcomputer (CPU, RAM, ROM and memory control)
3. Real time clock
4. Input and output latches
5. Analog-to-Digital conversion
6. Digital-to-Analog conversion
7. Serial communications

The CPU board controls the ECG board which provides the analog ECG signal and is the output for the beeper signal. The microprocessor controls selection of the ECG leads such as paddles, electrodes, lead I, II or III and controls the ECG size for display on the CRT and the recorder and an independent size used for digital detection of ECG QRS complexes.

Operation of the pacer function is performed by having all the user setup controls received by the CPU board. Signals such as pace amplitude and pace current are converted from analog signals to digital data for microprocessor operation and manipulation. The pacer board operates as an output device controlled by the CPU board. Pace amplitude is set by the microprocessor through a digital-to-analog converter and the rate is set by microprocessor digital control lines.

The defibrillator charging and discharging function is controlled by the CPU board. The CPU receives all the user inputs and performs all the required logic for safe operation of the defibrillator. Diagnostic functions concerning the proper high voltage capacitor charging and operation of the defibrillator are provided by the analog signal VCAP representing the high voltage capacitor voltage and the signal x-DEFIBDISABLED which is a combination of several possible fault conditions on the defibrillator board.

When the defibrillator is discharged into the internal self test load, the energy delivered (peak current) is captured with circuits on the CPU board and calculations are performed by the microprocessor.

All the user inputs from the front panel control are received by the CPU board. The CPU will then distribute the appropriate control signals as required.

A serial communications data line is used to transmit data between the CPU microprocessor and the CRT board microprocessor. The data includes ECG trace data and messages for presentation on the CRT display and strip chart recorder.

CPU Hardware

The microprocessor circuits consist of an 8051 microcomputer (U29), memory decode logic (U16, U20, U24), data bus multiplexing (U18), and memory, 8k of RAM (U26) and 16k of ROM (U27). This collection of circuits allows the processor to run programs from both the onboard 8051 memory space and the outside memory space. The 8051 processor runs continuous checks of all the memory locations to ensure they are operating properly.

All the digital input signals to the CPU board go to individual latches (U7, U19) or to the onboard gate array circuit (U24). These signals are read into the RAM memory by the microprocessor where the proper action is initiated. Digital output control signals are provided on a discrete latch (U13) or on the gate array circuit (U24).

The real time clock (U23) retains date and time as long as the main PD1200 battery is connected. When the machine is turned off the real time clock operates at a reduced voltage and draws insignificant current from the battery. The components that maintain the battery operation are CR12, CR13, CR14, R15, C19, C56 and U4. The diodes (CR15, CR17) isolate the +5 volt and +12 volt power supplies from the real time clock chip when the system power is off.

The CPU board controls and monitors all the knobs and switches on the machine, the paddles and accessory cables. The front panel switches are input to a matrix array of rows and columns that the microprocessor can read to determine which switches have been selected. These signals are labeled SWCOL 0-3 and SWROW 0-5 and they connect to the gate array (U24). The main selector switch is monitored by the discrete latch (U19). Additional external inputs are received by discrete latch (U7).

The gate array has several independent functions collected into a single custom IC circuit, several of the internal functions have been described as they pertain to specific functional operations of the CPU board. Additional functions in the gate array are clock divider circuits, pacer timing signals that operate the pacer board and allow back panel control of the pacer output, and an independent watch dog timer and reset circuit. The watch dog timer provides functional safety in the unlikely event of a failure in the microprocessor program execution. If the microprocessor fails to update the watch dog timer every 4.5 msec, the timer will reset the CPU board. This reset signal is seen on the gate array (U24 -44) or the microprocessor (U29-9).

The analog section of the CPU board consists of analog-to-digital (A/D) conversion and digital to analog (D/A) conversion. The A/D section has an 8 bit successive approximation converter with on-board 4 input multiplexer. The required reference voltages are provided by U7 + 2.5 volts and U2 pin 6 +5.0 volts. The analog signals that are input to the 8 input multiplexer are gain selectable between 1X at U12 pin 1 or 2X at U12 pin 7. The analog signals input to IC U5 are VCAP, IPEAK, ISENSE, IPOT, +18/-12.6, +12VSW and RPOT. The signals input directly to the A/D converter are ECGP, 10VSNS, U5 at 1X and U5 at 2X.

The D/A section consists of an 8 bit cmos converter (U8) and a buffer stage for gain and offset using opamp U3. The output signals are ECGOUT U3 pin 1 that goes to the back panel and ICTL U6 pin 7 that is used to control the pacer current output on the pacer board.

Serial communications provides communication between the CPU board microprocessor and the CRT board microprocessor and the connector at the rear panel. The CRT-to-CPU board connection is direct between the respective microprocessors and is buffered to the rear panel by IC U11. The input line from the rear panel is U11 pin 17 and the output line is U11 pin 18.

The circuit responsible for calculating the defibrillator energy in the self test mode consists of U1 and its associated discrete components. The signal generated is the peak current generated in the 50 ohm self test resistor located near the CRT tube. The peak detect circuit is calibrated to the defibrillator output after the defibrillator calibration is confirmed. Transistor Q1 is used to reset the sampling capacitor (C2) just prior to a defibrillation self test discharge.

5. DEFIBRILLATOR

The defibrillator circuit is responsible for three major functions:

1. charging the high voltage capacitor to the level specified by the front panel setting
2. providing feedback (1000:1) on the high voltage capacitor's voltage level
3. discharging the high voltage capacitor energy through paddles or the multi-function cable

The defibrillator board is active only when the front panel Selector Switch is set to DEFIB ON or any of the energy settings. It receives power at this time via signal DEFIBON, but is idle until the CPU initiates charging the high voltage cap.

The first time after power-up that Defib mode is selected, the CPU checks that the high voltage cap reads zero volts prior to allowing the defibrillator to charge. If not at zero, the CPU reports an ERROR 46 on the CRT display.

Charging

A charge may be initiated in two ways - pressing the Charge button on the front panel or the one on the paddles. When the CPU detects a charge request, it controls the charging process as follows. All of the following conditions must be satisfied before the high voltage cap can be charged.

1. Open the safety relay (x-SAFREL) across the high voltage capacitor.
2. Set the charge rate (x-CHGRATE) to a fast or slow rate, depending on the required energy level and the battery capacity. The fast rate will be used unless the selected energy level is set to 100 joules or less, or when the battery is becoming depleted. This is done to extend the number of charges available from the battery.
3. Activate charge enable (x-CHGENB).
4. Discharge buttons not active.

The defibrillator circuits begin charging the high voltage capacitor to the target voltage as determined by the front panel Selector Switch. The CPU continuously monitors the analog VCAP signal to ensure that the high voltage capacitor charges at the proper rate. Improper operation results in an ERROR 44. When the target voltage is reached, the CPU initiates a continuous beeper tone indicating that the defibrillator is ready to discharge. The target energy level is displayed on the CRT screen.

The defibrillator holds the energy for 60 seconds, with the energy level being refreshed as necessary during this period. The last 10 seconds of the hold period is indicated by an intermittent beep tone. After the 60 second period, if the defibrillator has not been discharged, the energy is internally dissipated by the safety relay (x-SAFREL).

Discharge

A discharge is initiated by depressing both Discharge buttons on the paddles or both buttons on the multi-function cable connector. This provides voltage to the patient discharge relay coil and notification to the CPU through the (x-DISCHARGE) signal. The CPU then controls activation of the patient discharge relay. There are two exceptions to immediate discharge: operating in SYNC mode and discharging through the multi-function cable. In SYNC mode, the discharge occurs near the peak of the ECG QRS wave. With the multi-function cable, if an open

circuit is detected, the discharge is not allowed and the message LEAD FAULT is displayed on the CRT.

Energy delivered to the patient goes through a wave shape inductor, as specified by the AAMI standards.

When the patient discharge relay is deactivated and the high voltage capacitor returns to the system side, the safety relay closes to internally dissipate the high voltage capacitor.

If the PD 1200 is in the self-test mode, the energy is delivered across an internal 50 ohm resistor. The microprocessor calculates the actual delivered energy from the peak current reading and displays a TEST OK or TEST FAILED message on the CRT. In the extended diagnostics mode, the actual peak current reading is displayed on the CRT.

DETAILED CHARGING OPERATION

Initiating High Voltage Capacitor Charging

The microprocessor controls several signals that are used to initiate charging the high voltage capacitor. Once the defibrillator board has received these signals, the board will locally charge the high voltage capacitor with a Pulse Width Modulator (PWM) controller (U1). The microprocessor will continue to monitor the changing VCAP signal to ensure proper charging operation.

To provide safety and to improve battery operating time, the defibrillator circuits are only powered when the main selector switch is in the Defib position. A high level on the signal DEFIBON J80-10 will close relay K1 providing power (+12VSW J80-11) to the defibrillator board.

The defibrillator capacitor is shunted for safety reasons with a resistor and relay to internally dissipate any energy remaining on the high voltage capacitor. When charging is initiated by the microprocessor, this relay is opened by providing a low level on signal x-SAFREL (J80-7).

Opamp (U6) provides feedback to the microprocessor via x-DEFIBDISABLED (J80-3) and drives transistor Q5 to activate the safety relay (K2).

The microprocessor can control the charging rate of the high voltage capacitor to improve battery efficiency by changing the duty cycle of a 16KHz signal called x-CHGRATE (J80-6). This signal is AC coupled by C6 and integrated and buffered by U2 to provide voltage at U1 pin 9. This voltage interacts with U1 pin 7 to set the basic operating frequency for flyback transformer T1.

When the microprocessor has completed the setup for initiating high voltage capacitor charging, the charge enable signal x-CHGENB (J80-8) is set low. This signal will pull U1-10 low initiating the PWM controller. The three signals (x-CHGENB, x-PATREL, x-SAFREL) are logically interlocked so that the proper combination must be present for charging to begin. This logic is provided by diodes CR13, CR12 and CR22.

Charging Operation

When the microprocessor initiates charging of the high voltage capacitor several signals are provided that improve charging efficiency and allow continuous monitoring by the microprocessor for diagnostic purposes.

The battery voltage is monitored so that if the voltage drops below 10 volts the PWM controller is halted until the voltage recovers above 10 volts This function is performed by opamp U2 and controls U1 pin 9. A low signal at this pin inhibits operation of U1.

The high voltage capacitor is charged by converting the system battery voltage to a pulsed high voltage via transformer T1. Control of this function is provided by the PWM controller (U1). It provides a basic operating frequency signal that is used to switch transistor Q7 providing current in the primary windings of transformer T1. Efficiency is improved in charging, by providing feedback of the current into the high voltage capacitor on every cycle of Q7 switching. The PWM controller is inhibited on each cycle until the high voltage capacitor current is nearly zero. This control is provided by diodes CR1 and CR2, IC U2, and transistor Q1. These components control U1 pin 3 by inhibiting the U1 oscillator with a high level when high voltage capacitor current is present. The PWM controller is also inhibited at U1 pin 4 if the transformer primary current exceeds a value set by resistor R50.

When the high voltage capacitor is charging, the microprocessor monitors the change in capacitor voltage as a diagnostic function. The signal VCAP represents a 1000:1 reduction in the actual capacitor voltage. The voltage divider resistors are 30MEG on the flyback transformer and typically 30K provided by resistors R11, R55, R56, R12 on the defibrillator board. This divided voltage is buffered by U2 where it provides a maximum voltage shutdown protection at U1-1 and is short circuit protected by R51 before leaving the board at J80-1.

Discharging the High Voltage Capacitor

Discharge of the patient relay is a two step process. The power provided to the relay is routed through the discharge switches on either the defibrillator paddles or the multi-function cable connector. The microprocessor then senses when the discharge buttons are depressed with a signal called x-DISCHARGE (J80-2). When the microprocessor has decided that all other conditions have been met, such as in the SYNC mode, it activates the signal x-PATREL (J80-9) to a low level. This signal is buffered by U5 and Q3 to drive transistor Q6 which activates the patient relay.

When the patient relay activation time is complete, the microprocessor releases the x-PATREL signal and allows the patient relay to return the capacitor terminals to the PD 1200 system side. Several hundred milliseconds later, the safety relay is closed to ensure the high voltage capacitor energy is completely dissipated.

6. PACER

The Pacer module produces and delivers user-controllable pace pulses to the pacing electrodes. It utilizes an analog switch, op amps, power FETs, a transformer, and an output section to deliver pulses to the Pace output leads. The amplitude and frequency of these pulses are determined by the setting of the front panel OUTPUT and RATE knobs.

Inputs

The CPU provides four signals to the Pacer circuit: ICTL, PACENB, and complimentary 25KHz pulses. They are sent in 40 mS bursts by the CPU as inputs to the amplifier section of the Pacer. ICTL sets the amplitude of the 25KHz pulses through the analog switch (U3). PACENB is sent by the CPU to enable the Pacer circuit. When this signal is not present, the power FETs (Q1 and Q2) are disabled. PACENB is also used to close the pace relay.

The output pulses of U3 are amplified through op amps (U1 and U2) whose outputs drive the power FETs to produce a current through the transformer primary. The resultant secondary waveform is rectified, filtered, and output to the Pacer leads. The feedback control of the primary current occurs through each op amp and R1. As a result, the secondary current is controlled since T1 operates as a current transformer.

Outputs

The signal PACEINOP is sent from U5 to the CPU when the current times the patient resistance exceeds about 320 volts. This is used to detect leads off.

The pace pulse output goes to the pacer output connector on the machine front via P2-1, 2, 7, and 8, and to the patient defib connector via P2-11, 12, 15, and 16.

When the pacer is not in use, the relay is open, providing about 600 volts isolation between the pace electrodes and the paddles. This secondary level of protection is in addition to the 5000 volt isolation provided by the protect relay when the defibrillator is activated.

7. ECG

The ECG board has a system circuit side and a patient isolated side. On the patient isolated side, there are two inputs for ECG signals. These are the standard 3 lead ECG input and a paddle input. The paddle input can be disconnected with a high voltage isolation relay. Further protection is offered by series resistors and the leadselect relays. The 3 lead ECG input is protected with input voltage transient suppressors, the lead select relays, series resistors, and diode clamps. The 3 lead input is sensed for a leads off condition only when the 3 lead input is selected. Both ECG inputs (leads and paddles) follow the same signal conditioning path after the lead select relays. The signal path consists of RF input filtering, an instrumentation amplifier, a slew limiting and baseline restoration stage, a gain and 100 Hz low pass stage and then a voltage to PWM (Pulse Width Modulator) conversion for transmission over the patient isolation barrier to the system side. Other circuits on the isolated side include leads off detection, Hislew detection and drive circuits for the lead select relays.

The system side circuits consist of ECG signal conditioning, isolated side power supply drive, protect relay coil drive and a beeper drive circuit. The ECG signal conditioning path consists of a PWM to voltage conversion, a low pass and 60 Hz notch filter followed by a gain selection stage. The isolated power supply runs at 50 KHz from the -12.6 volt regulated supply. The beeper drive circuit operates at two frequencies. All alarms are at a higher frequency and are not adjustable in volume whereas the QRS beep is lower in frequency with a volume adjustment.

Input Protection

The ECG patient connections are protected with voltage transient suppressors (SG2, SG3, SG4) at each of the three input leads and at the paddles input (Pacer board SG2). A second level of protection for the opamp inputs is accomplished with series input resistors and diode clamps to the power supply rails (CR7, CR8, CR13, CR14). These diodes have non-symmetrical reverse leakage currents and are used for ECG lead off detection. Protection between the paddle inputs and the three lead inputs is achieved by the Protect Relay (K1), series resistors, zener diodes (CR1, CR2), movs (M1, M2), and the lead select relays (K2, K3). The movs limit the voltage if an external defibrillation voltage is applied from the paddle to any of the 3 ECG leads.

Lead Selection

Inputs to the ECG amplifiers may come from the three standard ECG leads (RA, LA, LL) or from the defibrillation paddles. These inputs go to lead select relays (K2, K3) to provide the standard lead configurations of lead I, II, or III and to select the paddle input. The relays also provide isolation of the paddle inputs and the 3 ECG leads.

The lead select relays are of a latching configuration with each relay having a separate set and reset coil. These coils are driven by a quad FET switch (U8) which are activated by four separate opto-isolators (U5, U6, U7, U8). The opto-isolators are driven directly from the CPU gate array.

Isolated Side Signal Path

The lead select relays can select paddle monitor or three lead ECG in the form of lead I, II, or III. The relay outputs are filtered prior to the first stage instrumentation amp (U4). This input has an input impedance greater than 10 Mohm at 10 Hz and an input dynamic range of $\pm$ 500 mV. The instrumentation amp configuration provides excellent common mode rejection by using

precision matched gain resistors. The first stage instrumentation amplifier has a gain of 10x. The second stage (U6) after the instrumentation amplifier provides a dual function. First, it limits the slew rate of the signal before it can pass to subsequent stages. This happens when the input signals exceed 23 v/sec due to events such as internal pace pulses or noise. The second function is to provide a signal to the high slew detection circuit (U2) when high slew signals are present.

Also incorporated into this stage is a baseline restore circuit (U5) that can inhibit the input signal from reaching the following stages. This restore circuit is controlled by the main CPU and is used to speed the ECG recovery following large disturbances in the input signal.

The output of the baseline restore circuit is then AC coupled to a gain of 140 stage (U6-7). This provides a low frequency rolloff of -3dB at .5Hz and -3dB at 100 Hz. Feedback is provided (Q7, Q8) to restore the ECG baseline when a prolonged DC offset is present. The output of this stage goes to the voltage to PWM converter (U7) for transmission across the patient isolation barrier.

Voltage to PWM Converter

The input signal for the PWM converter (U7) is received from the gain of 140 stage (U6-7). The input voltage goes to a summing node in the PWM stage to provide modulation proportional to the input signal amplitude. The modulation frequency is 5400 Hz. A signal amplitude of 5 mV (RTI) provides an 80% depth of modulation. Two precision temperature compensated zener diodes (CR23, CR24) are used to provide a stable current source independent of power supply variations. The PWM output is transmitted across the patient isolation barriers to the system side via an opto-isolator (ISO4). This opto-isolator is biased to be partially ON (R43) to provide faster rise and fall times.

Baseline Restore

In the event of a prolonged out of range input signal or leads off condition the microprocessor can open the analog switch (U5) just prior to the AC coupled stage. This prevents saturation of subsequent stages that may take a long time to recover. When the input signal returns to a normal range, the switch is closed. This out of range condition will typically only occur during defibrillation or as non-invasive pace pulse.

Leads Off

Detection is made of a disconnected ECG lead on the RA, LA and LL leads. The paddle lead is terminated so the paddle leads off status cannot be detected. For the three ECG inputs, the leads off status is detected by using clamp diodes at the ECG inputs (CR7, CR8, CR13, CR14). During paddle monitoring, leads off is not detected on the 3 lead ECG. It is also possible to get a leads off message by receiving a large signal greater than approximately .5 volts on either the 3 ECG leads or the paddles input.

The leads off status is detected from each of the three opamps (U3, U4) in the instrumentation amp. This will cover all possible combinations of removed leads. These three signals are diode ORed together (CR10, CR11, CR12) and are the input to the leads off detection circuit (U1). When any one of the two input opamps drops below approximately -8.75 volts or if the differential opamp stage output exceeds $\pm$ 8.75 volts the leads off signal is sent to the main CPU (ISO1).

Hislew

The second stage amplifer of the ECG signal, provides a slew limit of 23 volts/second by saturating at this high slew rate. At this slew rate, the AC-coupled Hislew circuit will detect and provide a signal to the main CPU (ISO4).

SYSTEM SIDE

Power Supply for patient isolated circuits

The supply operates at 50 KHz and the drive signal (chopper) is provided by the CPU gate array. This is buffered (Q5) and AC-coupled (C42) to allow the power supply to use the regulated -12.6 volt system power. The power supply switches the isolation transformer (T1) from between ground and -12.6 volts through the series capacitor (C39).

ECG Signal PWM to Voltage conversion

The PWM signal is transmitted from the isolated side to the system side via an opto-isolator (ISO4). The opto-isolator is part of a circuit that has feedback (U10) to maintain proper operation when the opto-isolator varies its transfer ratio with changes in ambient temperature. A stable signal amplitude is formed by a comparator (U9) and a pair of precision temperature compensated zener diodes (CR26, CR27).

Low Pass and Notch Filter

The next stage (U11-1) is a 3rd order low pass filter which operates in conjunction with a twin-T notch filter (U11-7) set at 60 Hz or 50 Hz depending on configuration. These two filters provide a frequency response of -3dB at 40 Hz.

Gain Selection Stage

The last stage (U13, U14) allows the microprocessor to select the ECG gain. This gain controlled signal (PECG) is read by the microprocessor every 2 msec. It is typical to have the microprocessor change the gain every 2msec, multiplexing between the auto gain selection for the digital signal processing and the gain used for display on the CRT and Recorder.

8. CRT

The CRT control board receives messages and data from the CPU board and controls the presentation of these messages and data to both the recorder and CRT monitor.

The CRT microprocessor chip can send data and instructions to the recorder and can receive recorder status messages in return. The basic feature of this control is to turn the recorder on/off, load paper, print messages, print ECG data, and receive recorder error messages such as "No Paper".

The display of data on the CRT is accomplished in two steps. First, the CRT microprocessor formats the messages and ECG data it has received from the CPU, then loads this data into a display RAM. The CRT gate array controller chip will then retrieve this data from RAM and use it to control the writing of messages and ECG data on the CRT. The CRT is refreshed every 16 msec during which 8 msec is used to write 1000 ECG data points and 8 msec is used to write the characters.

The controller chip uses the RAM data to provide outputs of: X position, Y position and intensity for each step that forms a vector on the CRT monitor. Switch selectable filters on the X and Y DACS provide the correct compensation for the two modes of operation, character writing and ECG trace. These DAC outputs drive current amplifers which control the CRT beam deflection. The intensity data byte sets the baseline brightness of the characters and ECG trace by controlling the CRT cathode voltage.

Character beam intensity is controlled by modulating a single intensity bit to form a constant beam brightness independent of beam speed. During an ECG trace the baseline intensity is set with one intensity bit. This is supplemented by an analog circuit when the beam has rapid vertical movements. During rapid transitions, the beam appears dimmer and needs an enhancement to produce a uniform beam intensity. An additional intensity bit is used to form a bright marker on the ECG trace when an R-wave is detected in the SYNC mode of machine operation.

The CRT tube heater voltage is regulated at 11 volts to prevent excessive voltage when the battery charge is plugged.

CPU-to-CRT Serial Communications

The main CPU processor and the CRT processor (U2) communicate on a two wire serial link. The CRT processor receives data and commands for message display, ECG data display, and recorder control.

CRT Microprocessor Reset

The microprocessor is reset via the CRTRST J41-9 signal at CR6. When the machine is powered up, a pulse is generated by C90 and R6 that resets the CRT microprocessor at U2-9. The CRT microprocessor will then initialize the X & Y DACs and intensity lines. The CPU board will generate two additional reset pulses, check RAM, and execute self test diagnostics. When the diagnostics are completed, the CRT microprocessor begins message and ECG data display, and recorder control.

Recorder Interface

The recorder will print a single line of messages, mark a detected R wave, and print continuous ECG data. Control of the recorder is accomplished via an 8 bit bus (U2-0 to 7) that is used for both control words and data. An additional 10 lines are used for control and recorder status feedback. Four of the ten lines connect directly to the CRT microprocessor while the other six lines are multiplexed onto the 8 bit control and data bus (U1). This bus is a bidirectional open collector port on the CRT microprocessor chip (U2).

Gate Array Microprocessor Interface

Control of the CRT gate array is accomplished by ten control lines from the CRT microprocessor to the gate array and a bidirectional data bus chip. The CRT microprocessor can set an address location for either the RAM or ROM by setting registers in the gate array using the bidirectional data bus chip (U25). With the address location set, the bus is used to read or write from either the ROM (U3) or RAM (U4).

A status line EOMC is returned from the gate array to indicate when a string of data is completely transferred from memory to the analog circuits.

Gate Array Functions

The gate array (U11) is designed to operate independent of the CRT microprocessor (U2). This will allow the CRT microprocessor to service the recorder while the gate array drives the CRT tube deflective circuits.

To display data on the CRT tube, the gate array program counter is set to a starting address. When the array starts execution, it sequentially retrieves control words from memory which are executed until the end of message (EOMC U2-13) command is retrieved. The array is halted until the CRT microprocessor initiates another execution.

The gate array has five control registers that are used to drive the CRT deflection circuits, the beam intensity, and to set up operating modes such as clock rate and filter selection (trace vs character).

The five registers are defined as follows:

- **X Latch** - 8 bit data to drive a DAC (U13 pins 5 to 13) for horizontal beam deflection.
- **Y Latch** - 8 bit data to drive a DAC (U14 pins 5 to 13) for vertical beam deflection.
- **Intensity Latch** - 8 bits (U11 pins 1,2,3,4,5,6,9,10) of individually selected data lines to set beam intensity and clock rate.
- **Blanking Shift Register** - An 8 bit word is shifted out serially (U11-7 BENBO) for each new X and Y data word. This is used only during character display.
- **Attribute Latch** - 4 bits individually selected to control operating modes such as End of Message (EMOC, U2-13), Blink Enable (Blink, U11-25), Filter Control (EXTR3, U11-8).

The gate array can read the ROM (U3) and is capable of reading and writing RAM (U4). The RAM is used to store 1000 bytes of ECG data with an R-wave marker, store a sequence of starting ROM addresses for characters, store ROM addresses for programmed wait and move instructions, and provide a stack for subroutine operations.

To display a trace on the CRT, the gate array will retrieve a single Y data point from RAM every 8 usec and latch it into the Y DAC register. Every 32 usec, the X DAC is incremented by one count having started at a count of 00Hex (left side of CRT display). Each Y data point also has an intensity and blanking byte to control the beam intensity. When an R-wave is detected, the sixth intensity bit (slew, U11-6) is set high. For normal trace intensity the fifth intensity bit (Intfy, U11-5) is set high. The blanking byte is not used in the trace mode.

During the character display mode, the gate array retrieves the character generation commands from ROM every 4 usec. Each command will provide an X and Y incremental movement and a blanking byte (BENBO, U11-7) to control intensity. The blanking byte is modulated during each step command to provide a constant beam intensity.

To properly display ECG trace and characters, the clock rate is changed and the analog deflection filters are switched. The clock rate (OCLK, U11-62) is controlled with the two high order bits of the intensity byte (EXTR1, U11-10 and EXTR2, U11-9) to provide 4 MHz for character and 2 MHz for ECG trace. The filter selections are controlled by the attribute bit (EXTR3, U11-8).

CRT Intensity Control

The intensity control circuits have three operational sections. They are a high slew signal which is a rectified signal proportional to beam deflection speed; TA9, a high slew inhibit switch (U12-11); and an adjustable current source (Q5 and R53) to control cathode voltage.

To display an ECG trace, there are three intensity controls implemented. The proper baseline intensity is selected with the intensity bit (INTFY, U11-5). When vertical deflection is fast, the beam speed on the phospher causes the trace to appear dim so an analog high slew signal proportional to beam speed is used to increase the beam intensity, resulting in a uniform ECG trace display. To indicate an R-wave detection by the CPU, an additional intensity bit (SLEW, U11-6) is used to substantially increase the beam intensity for a duration of two samples. This results in a very bright segment of trace where the R-wave was detected.

Deflection Circuits

The CRT beam position is controlled by circuits that produce current in separate X and Y magnetic deflection yokes. The CRT gate array controller chip synchronously provides 8 bit X and 8 bit Y data bytes to each of the deflection circuits. This digital data is converted into an X voltage (U6-1) and Y voltage (U6-7) and then used as an input to a current feedback circuit that regulates the deflection yoke current for X (U8, Q3, Q4) and Y (U5, Q1, Q2). Because the beam position is proportional to current, this type of circuit provides a stable and accurate control of beam position.

In the feedback portion of this circuit is an analog switch (U7) that can select between two feedback networks. One set of networks is used for character display and the second is for ECG trace display.

The CRT heater element is specified to operate between 10 and 12 volts. Because the battery voltage can reach 14.5 volts when fully charged, a series regulator (REG1) is used to maintain a maximum voltage of 11.7 volts.

VII

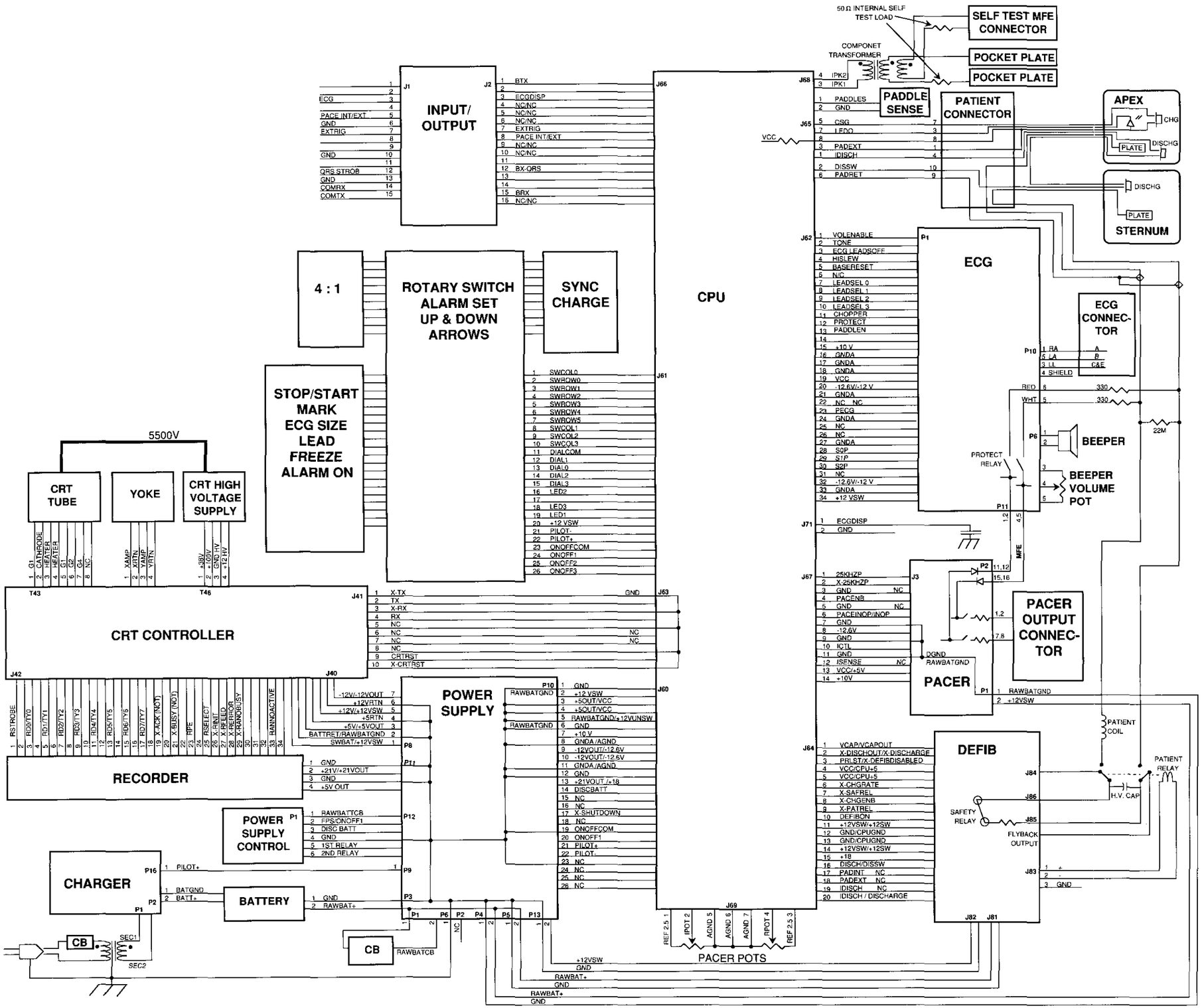
SCHEMATIC DRAWINGS

PD 1200 schematic drawings are included here to supplement the information presented in:

- Section V, Troubleshooting
- Section VI, Functional Descriptions
- Section VIII, Component Layout Drawings

LIST OF DRAWINGS

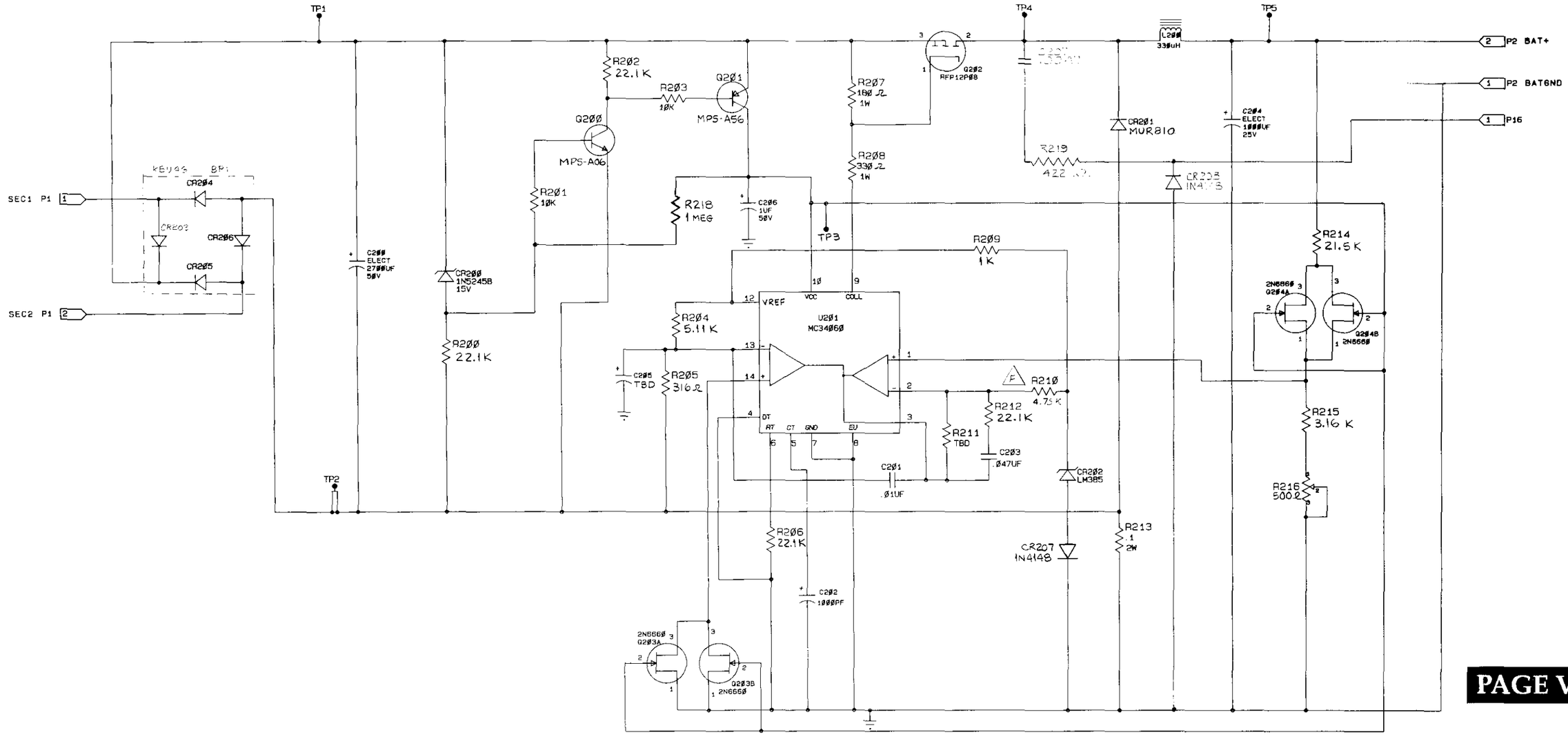
Description	Drawing No.	Page
1. System	1002-1028	VII-3
2. Charger	1002-1007	VII-4
3. Power Supply	1002-1036	VII-5
4. Power Supply Control	1002-1008	VII-6
5. CPU	1002-1031	VII-7
6. Defibrillator	1002-1010	VII-12
7. Pacer	1002-1030	VII-13
8. ECG	1002-1029	VII-14
9. CRT	1002-1027	VII-16
10. Input/Output	1002-1039	VII-17
11. Primary Wiring Diagram	1002-1022	VII-18



PAGE VII - 3

PD 1200 SYSTEM INTERCONNECTION DIAGRAM

DRAWING NUMBER 1002-1028



PAGE VII - 4

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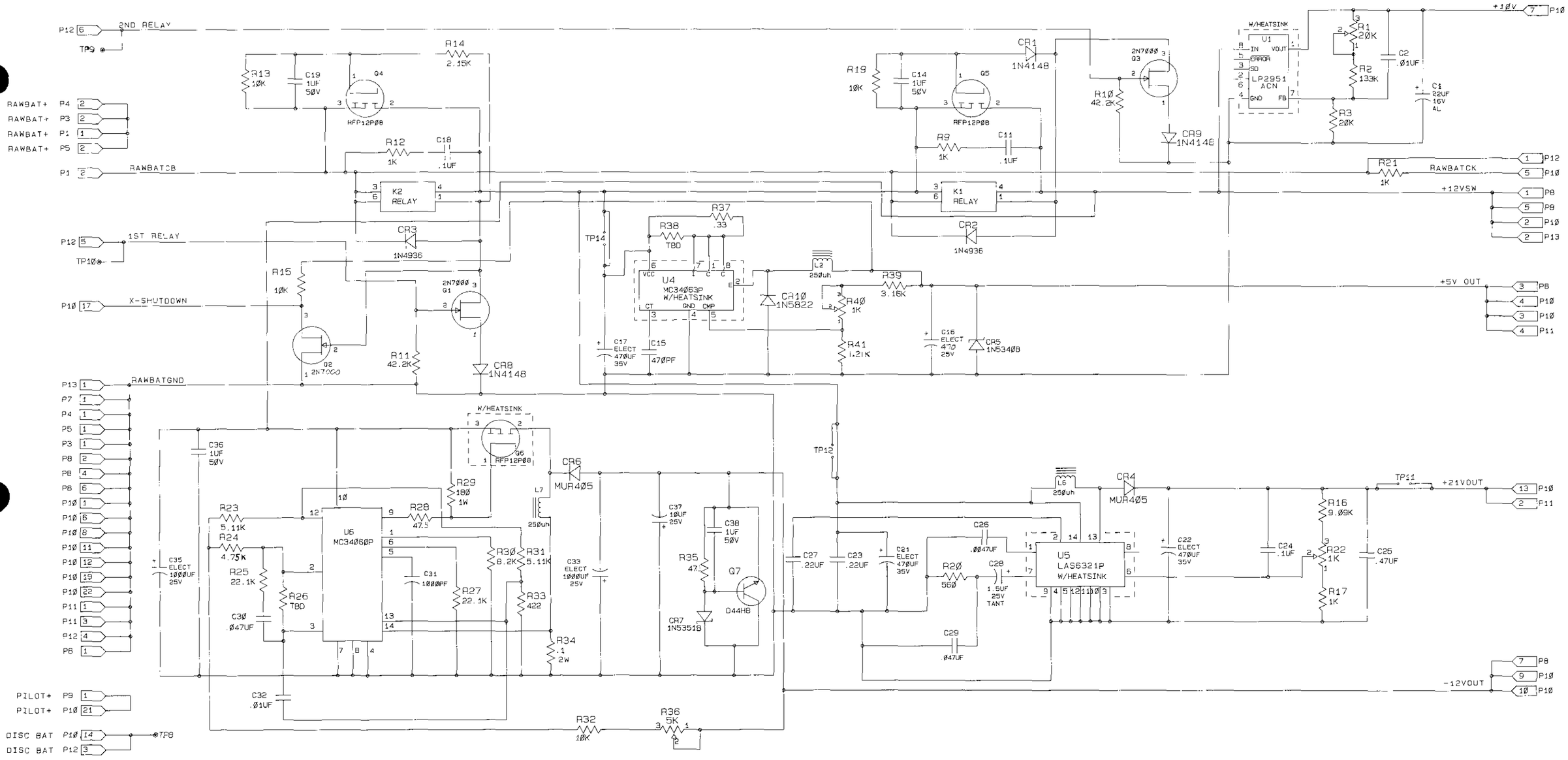
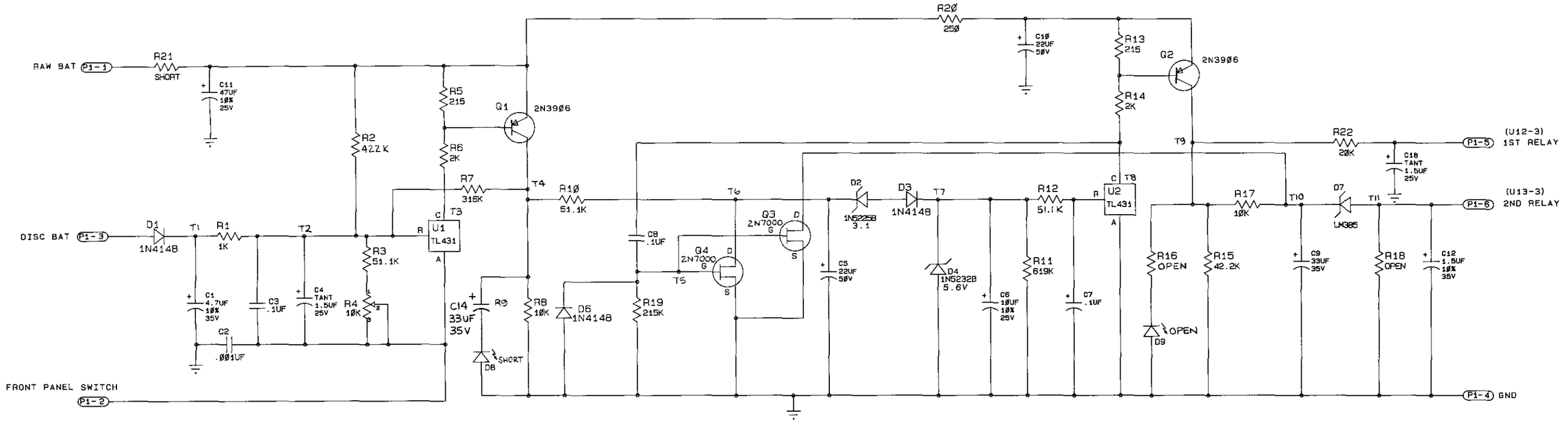
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: INCHES [MM] .XX ± ± .XXX ± ± △ ± ±	ANTAL DRW	DATE 7/25/88	ZMI CORPORATION 325 VASSAR ST. CAMBRIDGE MA. 02139
	J.SHOWN CHK	11/88	TITLE SCHEMATIC DIAGRAM CHARGER PCB
	DES	11/88	
MATL NA	APP	11/88	DWG NO. 1002-1007 REV =
FINISH NA	FILE NO		SHT 1 OF 1 SCALE: NA



PAGE VII - 5

REVISIONS

ZMI, CORP			
SCHEMATIC DIA POWER SUPPLY			
D		002-1036	A
AA#4667	SHEET 1 OF 1		10/89



REVISIONS

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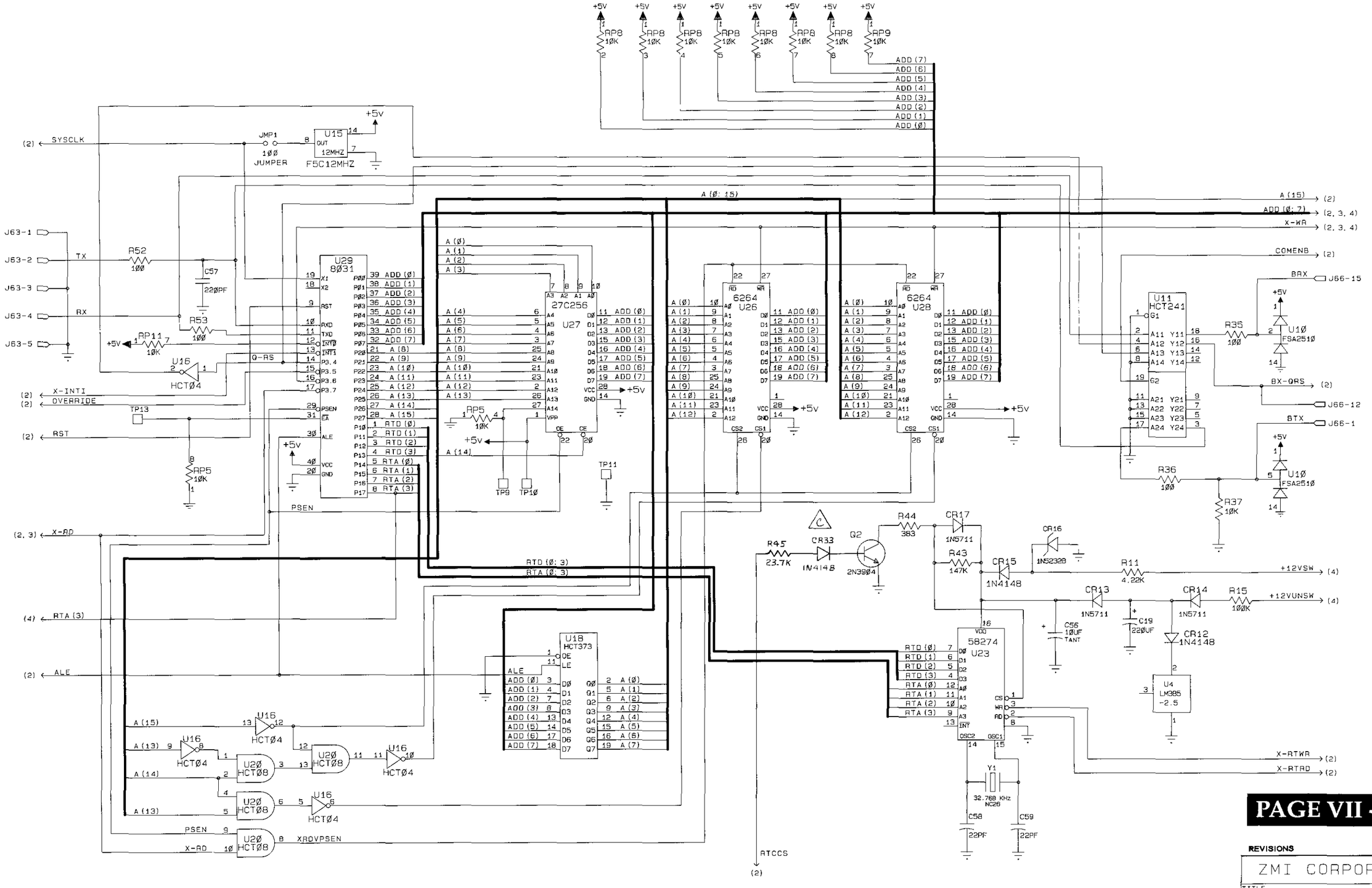
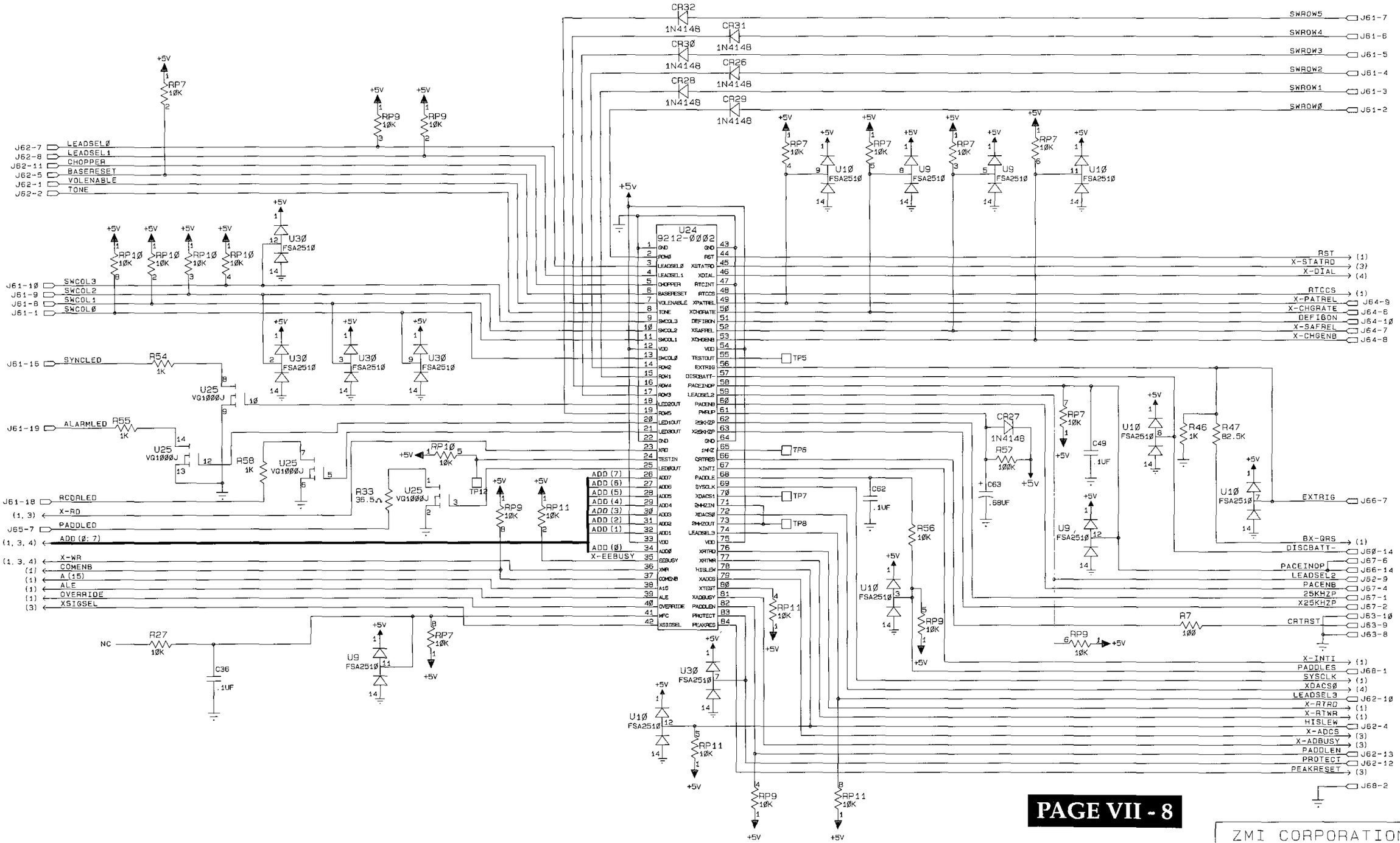
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE: INCHES [MM] .XX ± ± .XXX ± ± △ ± ±	ANTAL	DRW	DATE 10/13/88	ZMI CORPORATION 325 VASSAR ST CAMBRIDGE MA. 02139
	M	CHK	11/88	TITLE POWER SUPPLY CONTROL PCB SCHEMATIC
	M	DES	11/88	
MATL NA		APP	11-88	
	ECO	INIT		D DWG NO. 1002-1008 REV A
FINISH NA	FILE NO			SHT 1 OF 1 SCALE: NA



PAGE VII - 7

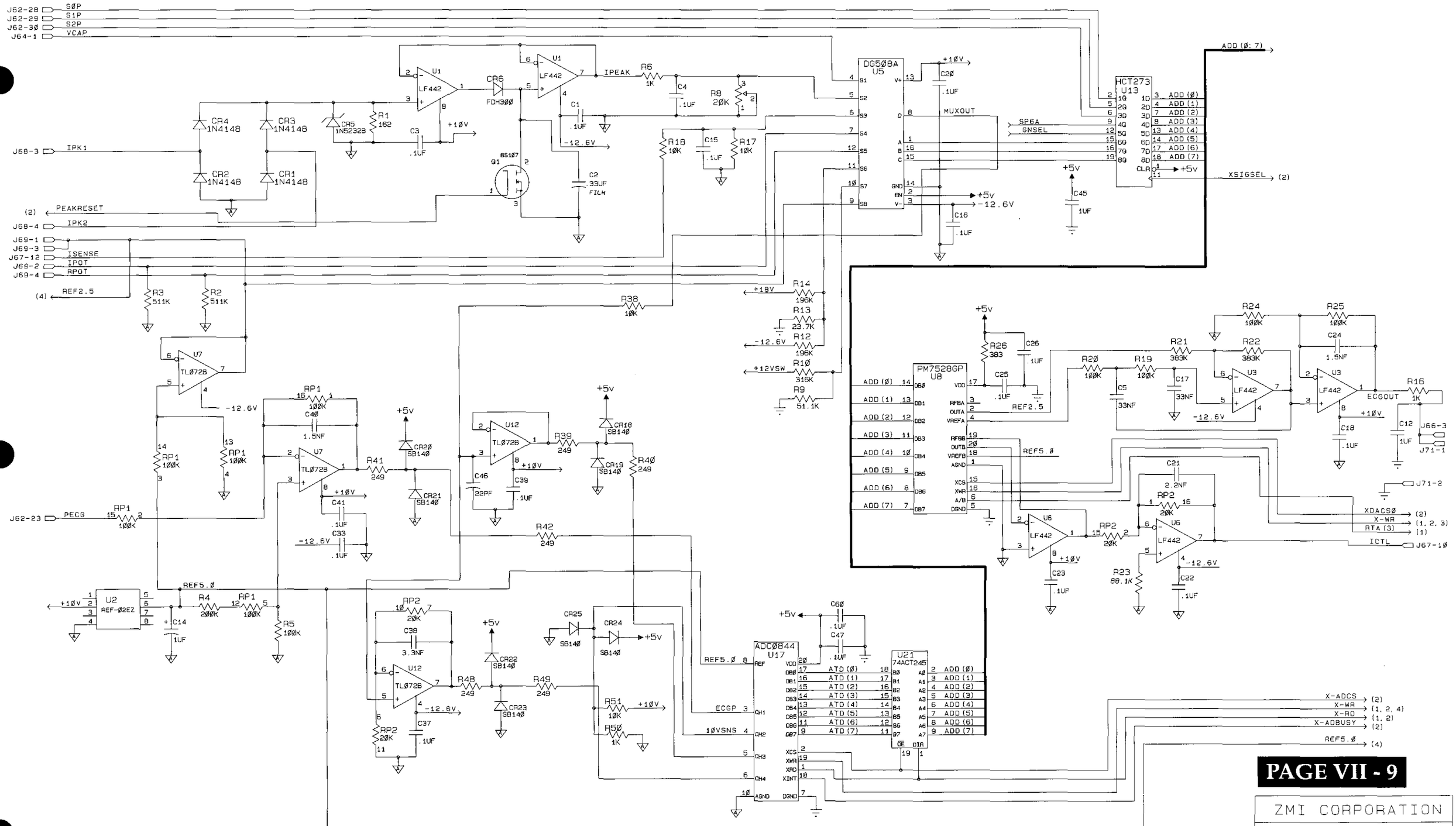
REVISIONS

ZMI CORPORATION			
TITLE: SCHEMATIC, CPU			
D		DWG NO. 1002-1031	REV C
12/89	SHT 1 OF 5	AA#4659	



PAGE VII - 8

ZMI CORPORATION			
TITLE: SCHEMATIC, CPU			
D		DWG NO. 1002-1031	REV. C
12/89	SHT 2 OF 5		AA#4657



PAGE VII - 9

ZMI CORPORATION			
TITLE: SCHEMATIC, CPU			
D		DWG NO. 1002-1031	REV C
12/89	SHT 3 OF 5	AA#4659	

(2) X-DIAL

J65-8 R34 178 +5V

J62-34
J61-20
J64-14
J64-11 +12VSW

J64-15 +18V
J60-13

J62-15
J67-14
J60-5 +RAWBATTCB

C10 .1UF
TP1
+12VUNSW
CR10 1N4745A

J60-6
J60-1
J60-12

J60-7 +10V
C8 10UF TANT
CR9 1N4745A
TP2

J60-11
J60-8

J60-4
J60-3

CR11 1N5234B
C27 10UF TANT
C48 .1UF
C42 .1UF
C52 .1UF
C53 .1UF
C31 .1UF
C35 .1UF
C43 .1UF
C61 .1UF
C55 .1UF
C50 .1UF
C44 .1UF
C51 1UF
C34 1UF
C32 1UF
C54 .1UF
+5V

J62-20
J62-32
J60-10
J67-8
J60-9

C9 10UF TANT
C13 .1UF
CR7 1N4745A
TP3
-12.6V

J60-2 +12VSW

C7 10UF TANT
C6 1UF
C11 .1UF
CR8 1N4745A
TP4

J60-20 ONOFF1
J61-24

J60-19 ONOFFCOMM

J61-11
J61-23

J60-21 PILOT+
J61-22

J60-22 PILOT-
J61-21

+5V RP11 10K 1 3 3 U16 HCT04 4

+5V RP11 10K 1 6 ONOF J66-11
DISCH J64-16
J65-2
IDISCH J64-20
J65-1
J64-19

+5V
J62-19
J67-13
J64-4
J64-5

J64-13
J64-12
J67-9
J67-7
J67-5
J67-3
J67-11

J69-5 GNDA
J69-6
J69-7

J66-2
J66-13

J62-16
J62-17
J62-18
J62-21
J62-24
J62-27
J62-33

EXTPAD
INTPAD

+5V RP4 10K 1 5
+5V RP4 10K 1 4
+5V RP4 10K 1 3
+5V RP4 10K 1 2
+5V RP6 10K 1 6
+5V RP5 10K 1 7
+5V RP5 10K 1 8

U19 HCT373
1 OE
11 LE
DIAL0 3 D0 Q0 2 ADD(0)
DIAL1 4 D1 Q1 5 ADD(1)
DIAL2 7 D2 Q2 6 ADD(2)
DIAL3 8 D3 Q3 9 ADD(3)
13 D4 Q4 12 ADD(4)
14 D5 Q5 15 ADD(5)
17 D6 Q6 16 ADD(6)
18 D7 Q7 19 ADD(7)

ADD(0:7) → (1, 2, 3)

+5V U9 FSA2510 2 14
+5V U9 FSA2510 7 14
+5V U14 FSA2510 9 14
+5V U14 FSA2510 11 14
+5V U14 FSA2510 12 14
+5V U14 FSA2510 8 14
+5V U14 FSA2510 7 14

X-SHUTDOWN J60-17

J65-6
J64-16
J64-17
J61-15
J61-14
J61-13
J61-12

R28 51.1K
R29 51.1K
C28 330PF
C29 330PF
R30 1K
R31 1K

PADEXT J65-3
PADINT J65-4

U22 HCT373
1 OE
11 LE
ADD(7) 19 Q7 D7 18 SP5
ADD(6) 16 Q6 D6 17 CHGRON
ADD(5) 15 Q5 D5 14
ADD(4) 6 Q2 D2 7
ADD(3) 9 Q3 D3 8
ADD(2) 12 Q4 D4 13
ADD(1) 5 Q1 D1 4
ADD(0) 2 Q0 D0 3

+5V RP6 10K 1 2
+5V RP3 10K 1 7
+5V RP3 10K 1 8
+5V U14 FSA2510 3 14
+5V U14 FSA2510 5 14
+5V U9 FSA2510 9 14
+5V RP3 10K 1 2

PACEINT/EXT J66-8
CSG J65-5
R32 1K
C30 .1UF
RP5 10K 3 1
RP5 10K 2 1
RP5 10K 6 1

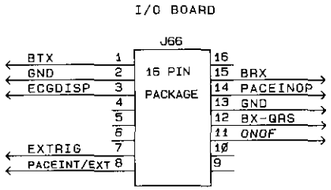
ECGLEADSOFF J62-3
X-DISCHOUT J64-2
PRELST J64-3

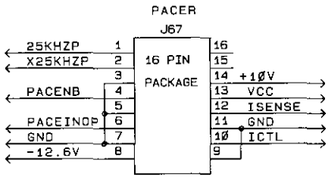
+5V RP6 10K 3 1
+5V RP6 10K 4 1
+5V U14 FSA2510 2 14
+5V U9 FSA2510 3 14

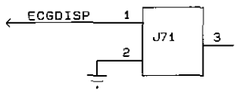
X-STATRD (2)

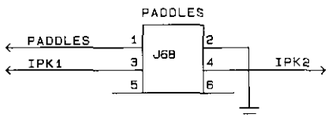
PAGE VII - 10

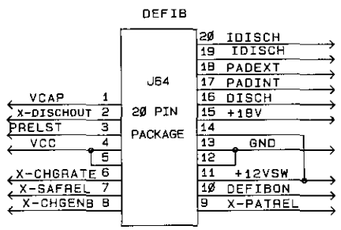
ZMI CORPORATION			
TITLE: SCHEMATIC, CPU			
D		DWG NO. 1002-1031	REV 2
12/89	SHT 4 OF 5		

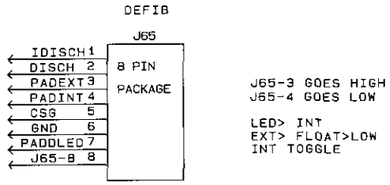






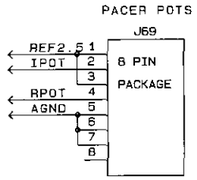


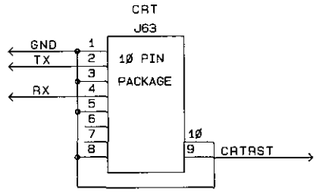


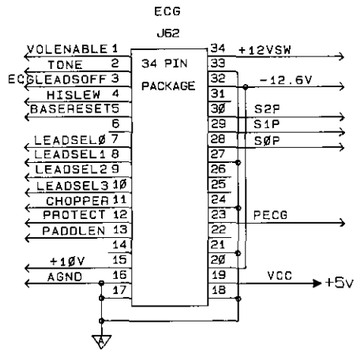


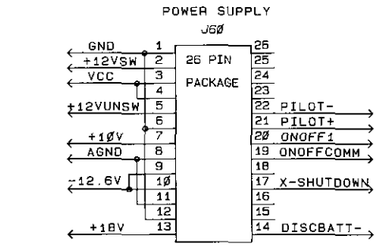
J65-3 GOES HIGH
J65-4 GOES LOW

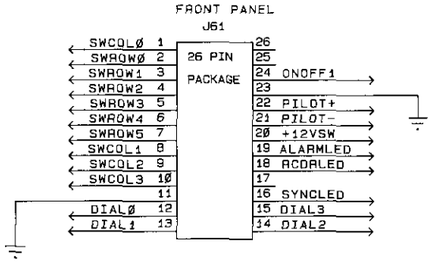
LED> INT
EXT> FLOAT>LOW
INT TOGGLE



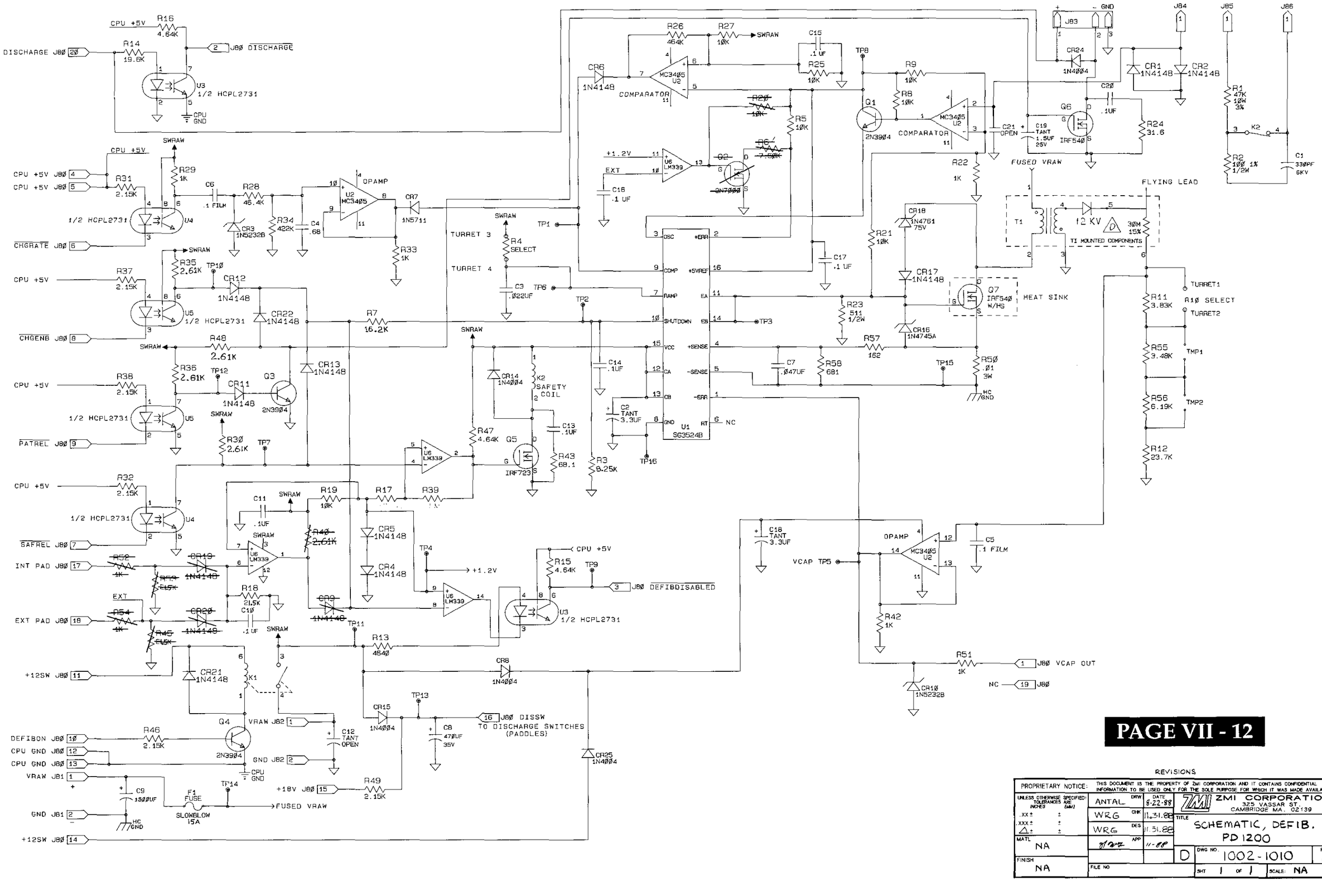








ZMI CORPORATION			
TITLE: SCHEMATIC, CPU			
D		DWG NO. 1002-1031	REV C
12/89	SHT 5 OF 5		



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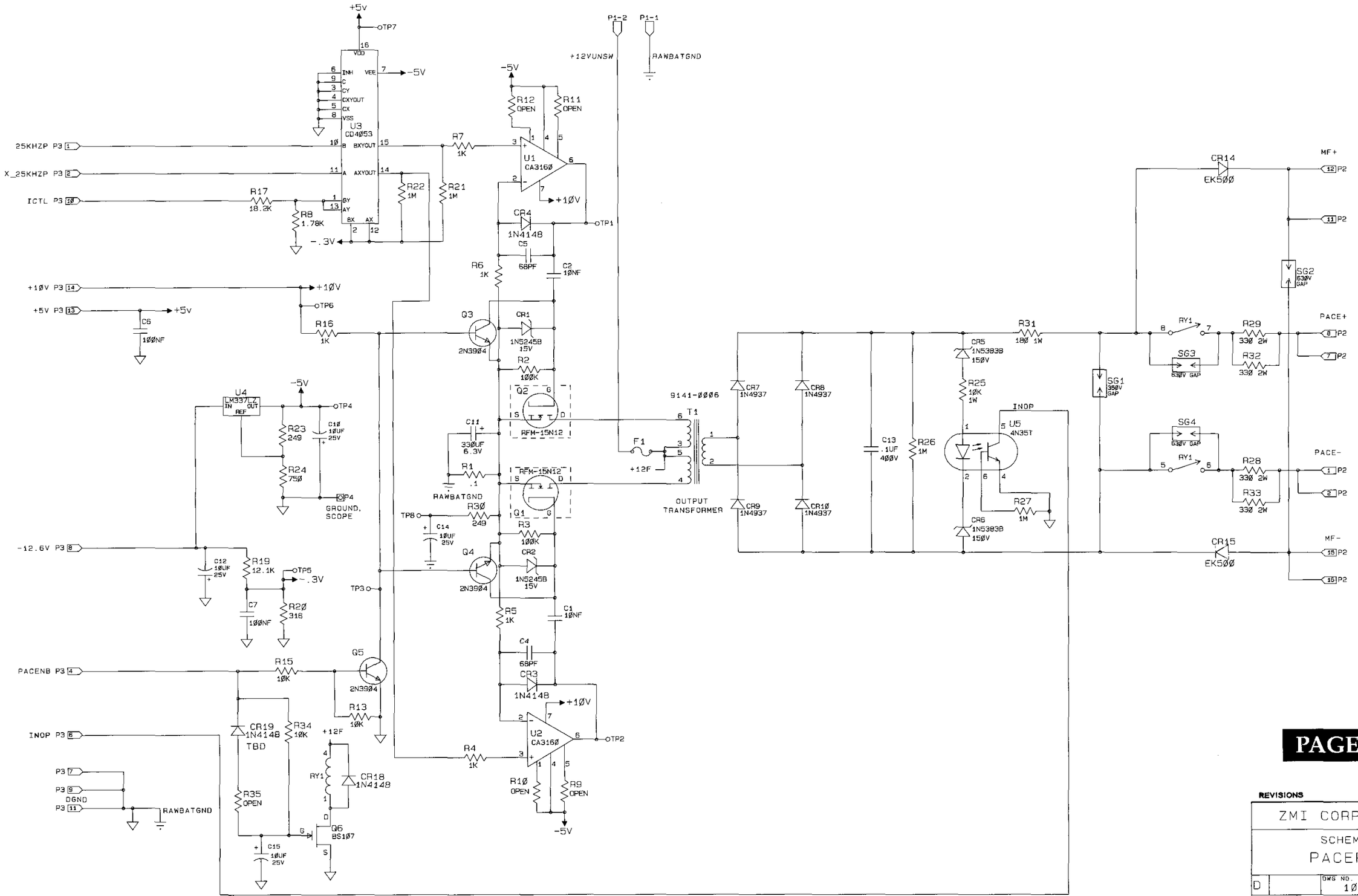
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE (INCHES) (MM) .XX ± ± .XXX ± ± ∠ ± ±	ANTAL DRW	DATE 5-22-88	ZMI CORPORATION 325 VASSAR ST. CAMBRIDGE MA. 02139
	WRG CHK	11.31.88	TITLE SCHEMATIC, DEFIB. PD1200
	WRG DES	11.31.88	
MATL NA	APP	11-88	D DWG NO. 1002-1010 REV D
FINISH NA	FILE NO		SHT 1 OF 1 SCALE: NA



PAGE VII - 13

REVISIONS

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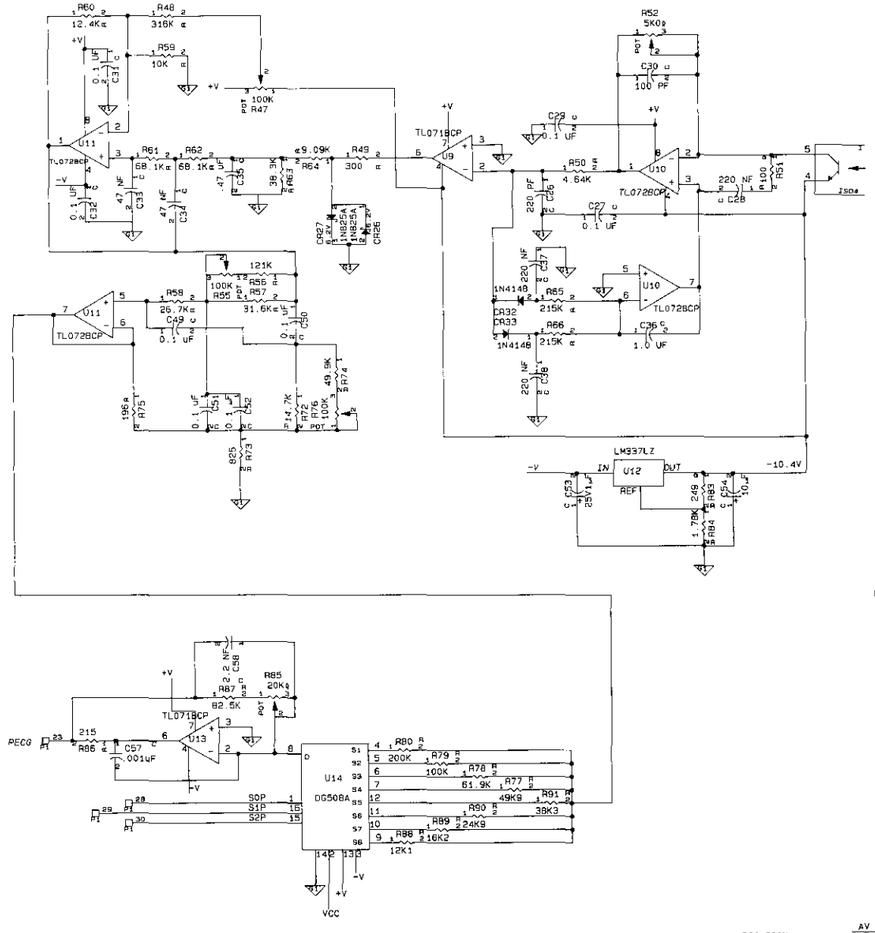
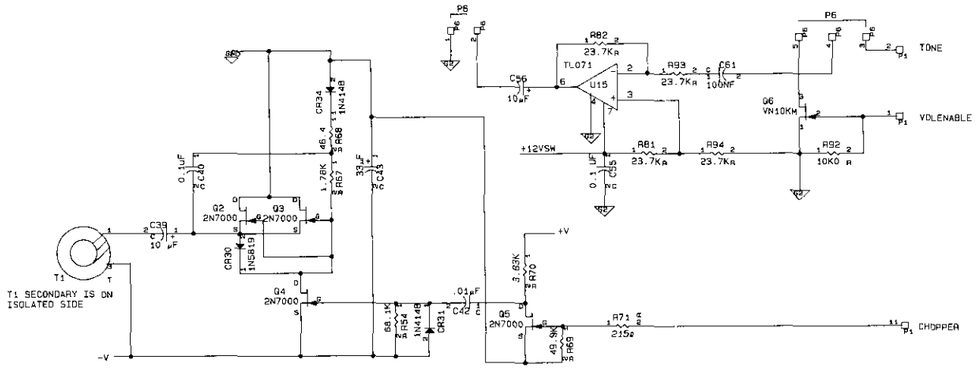
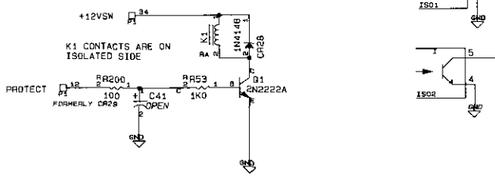
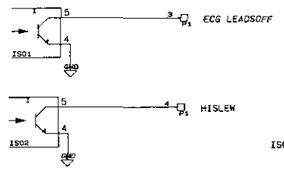
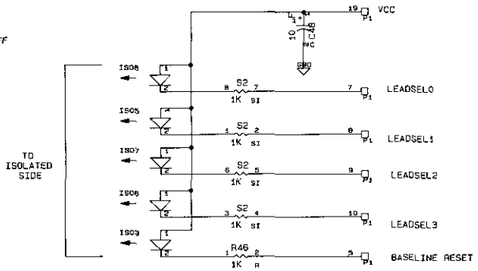
SCHEMATIC PACER BD			
D		DWG NO. 1002-1030	REV B
11/89	SHT 1 OF 1		AA#4668

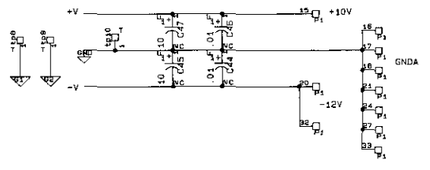












	AV	S1	S2	S0
R80-200K	0.5	0	0	0
R79-100K	1.0	0	0	1
R78-61K9	1.62	0	1	0
R77-49K9	2.0	0	1	1
R91-38K3	2.6	1	0	0
R90-24K9	4.0	1	0	1
R89-16K2	6.2	1	1	0
R88-12K1	8.2	1	1	1

P 1	
1	VOLENABLE
2	TONE
3	ECG LEADSOFF
4	HISLEW
5	BASRESET
6	N/C
7	LEADSEL0
8	LEADSEL1
9	LEADSEL2
10	LEADSEL3
11	CHOPPER
12	PROTECT
13	PADDLEN
14	
15	+10V
16	GNDA
17	GNDA
18	GNDA
19	VCC
20	-12V
21	GNDA
22	DAC
23	PECG
24	GNDA
25	N/C
26	N/C
27	GNDA
28	SOP
29	S1P
30	S2P
31	N/C
32	-12V
33	GNDA
34	+12VSW

P 6	
1	BEEPER
2	BEEPER
3	VOL POT
4	VOL POT
5	VOL POT

REV	DESCRIPTION	DATE	APP
B	CHANGE PER ECO # 298 REV B 1-5-90	AB	
A	RELEASE TO MFG PER ECO # 241		
2	CHANGE PER ECO # 193 PILOT RUN		

REVISIONS

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UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: (IN INCHES) XX+/- +/- XXX+/- +/- ANG+/- +/-

MATL

FINISH

DRN STM DATE 6-3-88
CHK AWF
DES
APP
ECO INI1

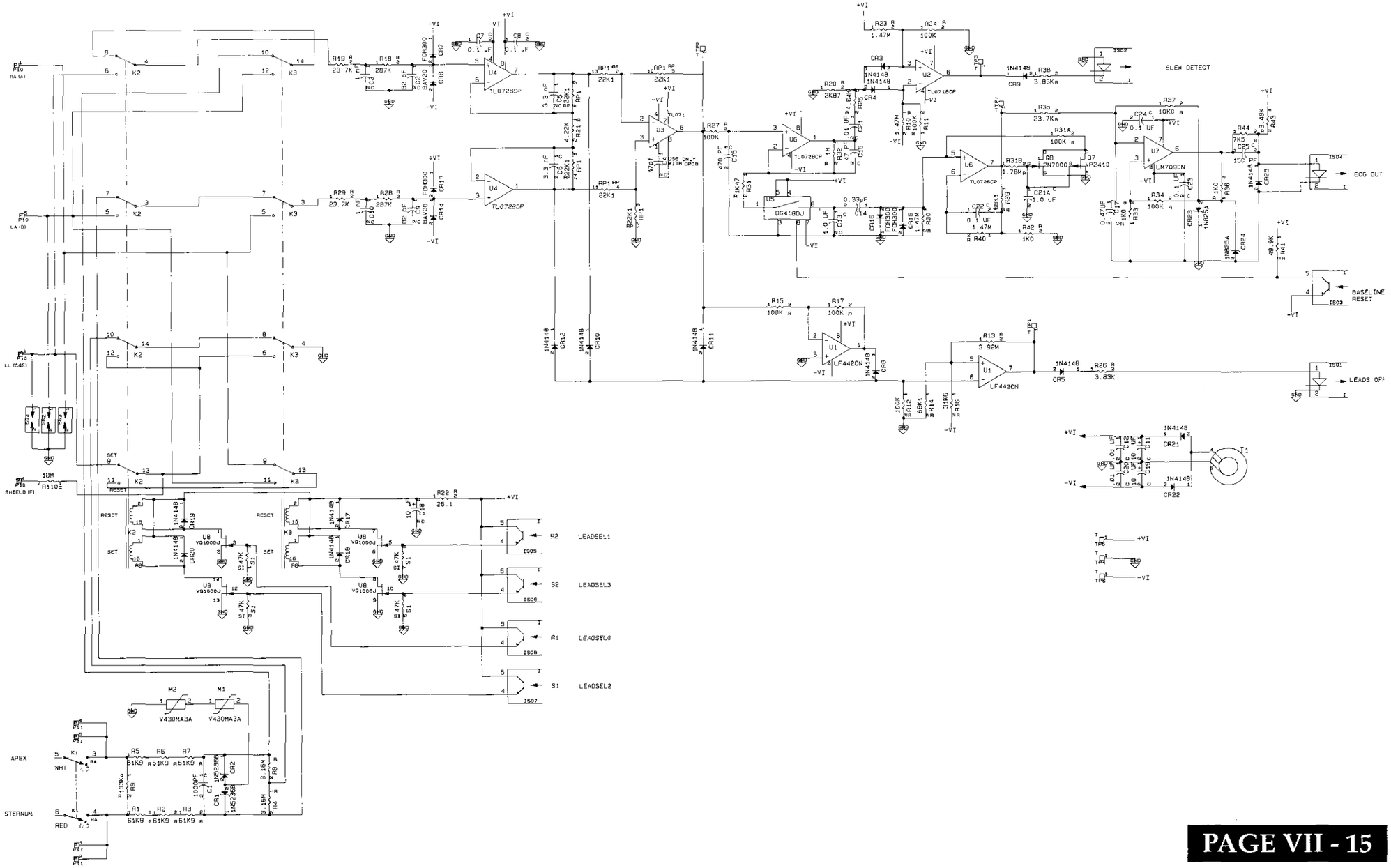
ZMI CORPORATION
900 WEST CUMMINGS PARK
WOBURN MA 01801

TITLE: ECG SYSTEM SIDE

DWG NO. 1002-1029 REV B

FILE NO \DASH\ECGMFES3.DWG

SHT 1 OF 2 SCALE



PAGE VII - 15

REVISIONS

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UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: INCHES [MM] .XX+/- +/- .XXX+/- +/- ANG+/- +/-

MATL

FINISH

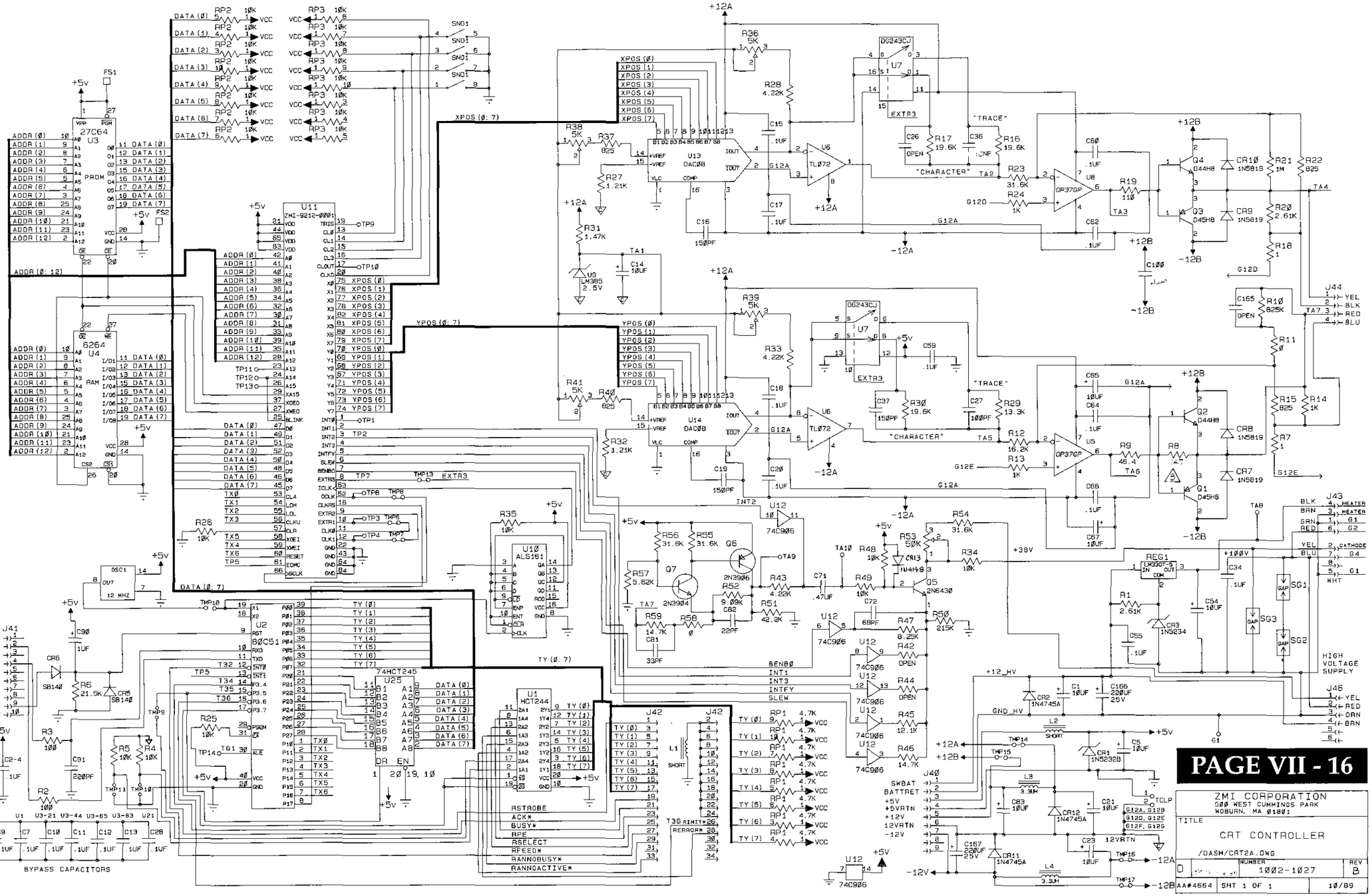
	DRN	DATE
STM		6-3-88
RWF	CHK	
	DES	
	APP	
ECG INIT		

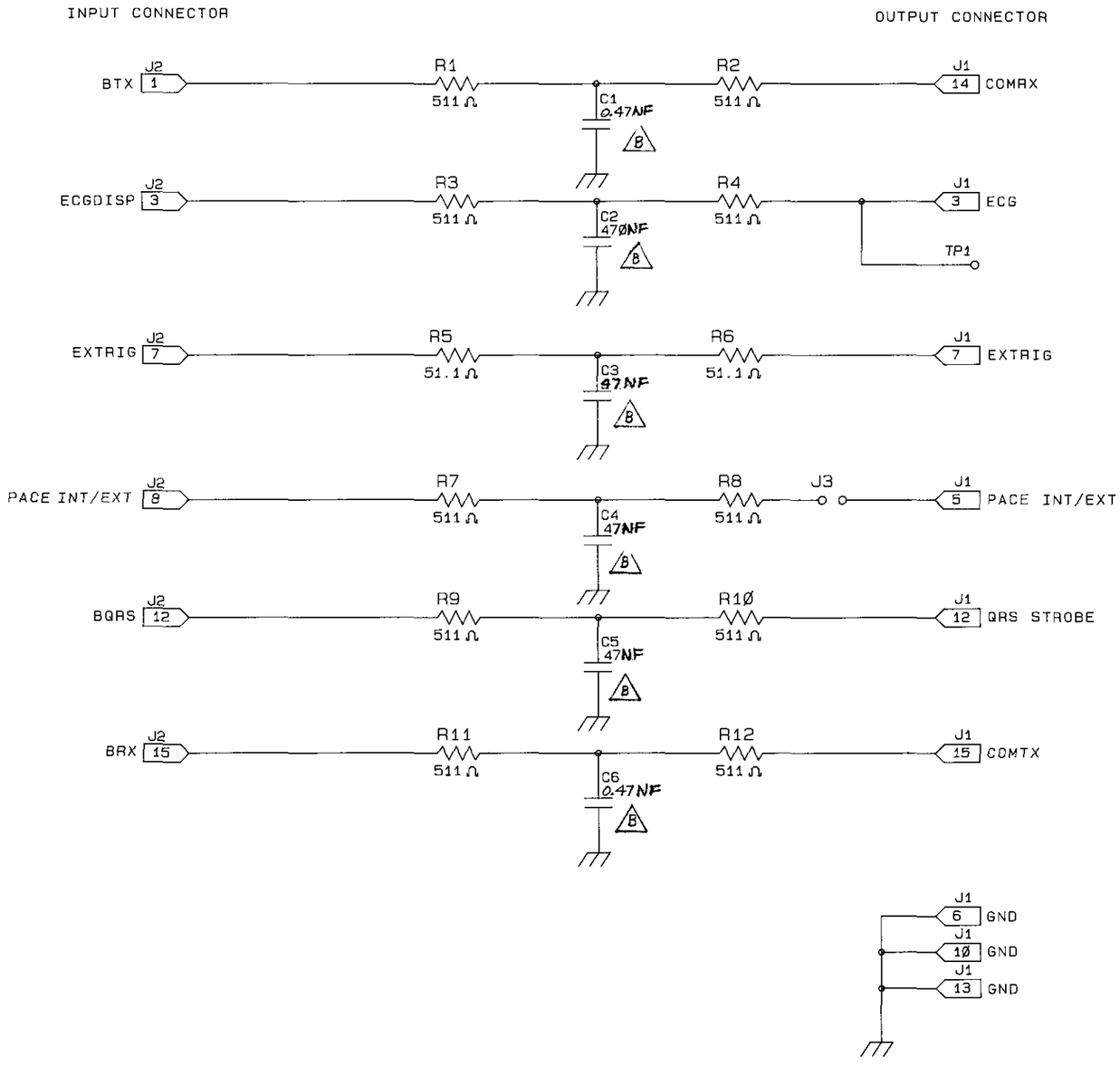
ZMI CORPORATION
500 WEST CUMMINGS PARK
WOBURN, MA 01801

TITLE: ECG ISOLATED SIDE

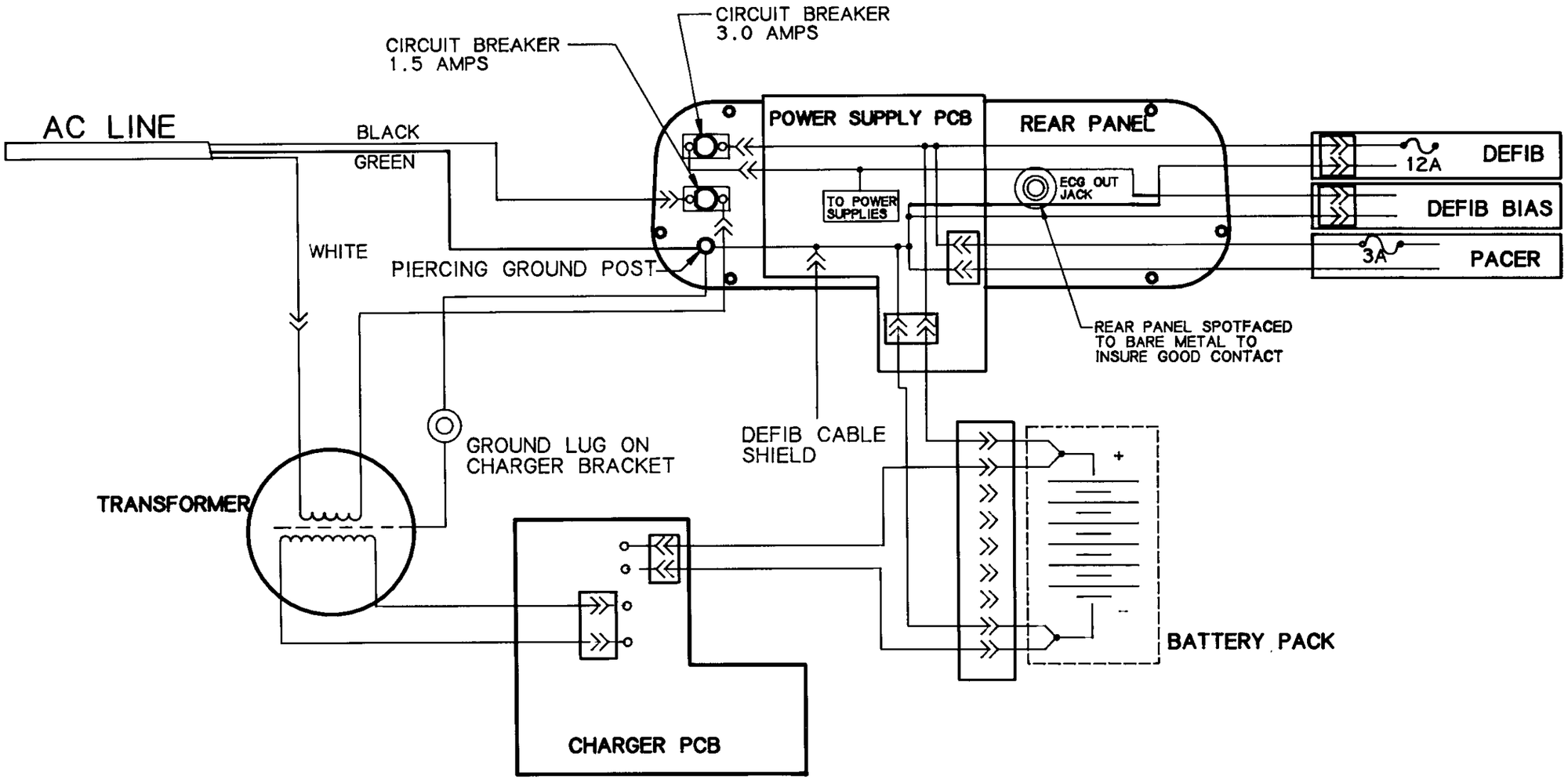
DWG NO. 1002-1029 REV 3

FILE NO \DASH\ECGMFEI3.DWG SHT 2 OF 2 SCALE


U3 27C64 PROM
U4 6264 RAM
U2 80C51
U11 ZMI-9212-0001
U25 74HCT245
U1 HCT244
U13 DAC08
U14 DAC08
U7 DG243CJ
U6 TL072
U8 OP37GP
U5 OP37GP
U9 LM385 2.5V
U10 ALS161
U12 74C906
REG1 LM330T-5
Q1 D45H8
Q2 D44H8
Q3 D45H8
Q4 D44H8
Q5 2N6430
Q6 2N3906
Q7 2N3904
XPOS (Ø:7)
YPOS (Ø:7)
DATA (Ø:7)
ADDR (Ø:12)
TY (Ø:7)
"TRACE"
"CHARACTER"
EXTR3
HIGH VOLTAGE SUPPLY
BYPASS CAPACITORS
PAGE VII - 16
ZMI CORPORATION
500 WEST CUMMINGS PARK
WOBURN, MA 01801
CRT CONTROLLER
/DASH/CRT2A.DWG
1002-1027
AA#4664
SHT 1 OF 1
10/89



ZMI CORPORATION			
TITLE: SCHEMATIC INPUT/OUTPUT			
C		1002-1039	REV B
12/89	AA#4662		SHT 1 OF 1



PD 1200
PRIMARY WIRING
DIAGRAM

DRAWING NUMBER 1002-1022

VIII

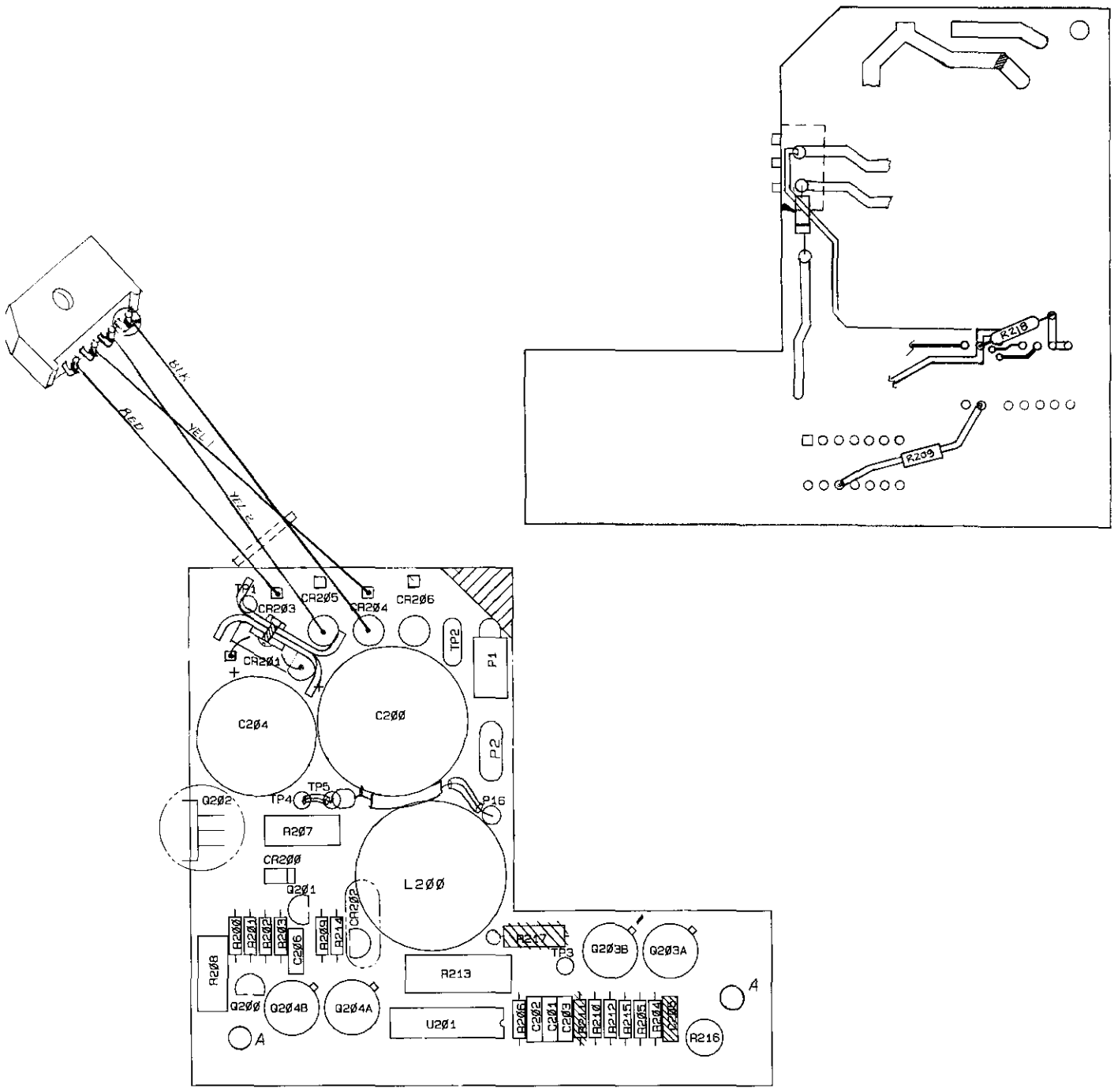
COMPONENT LAYOUT DRAWINGS

PD 1200 component layout drawings are included here to supplement the information presented in:

- Section V, Troubleshooting
- Section VI, Functional Descriptions
- Section VII, Schematic Drawings

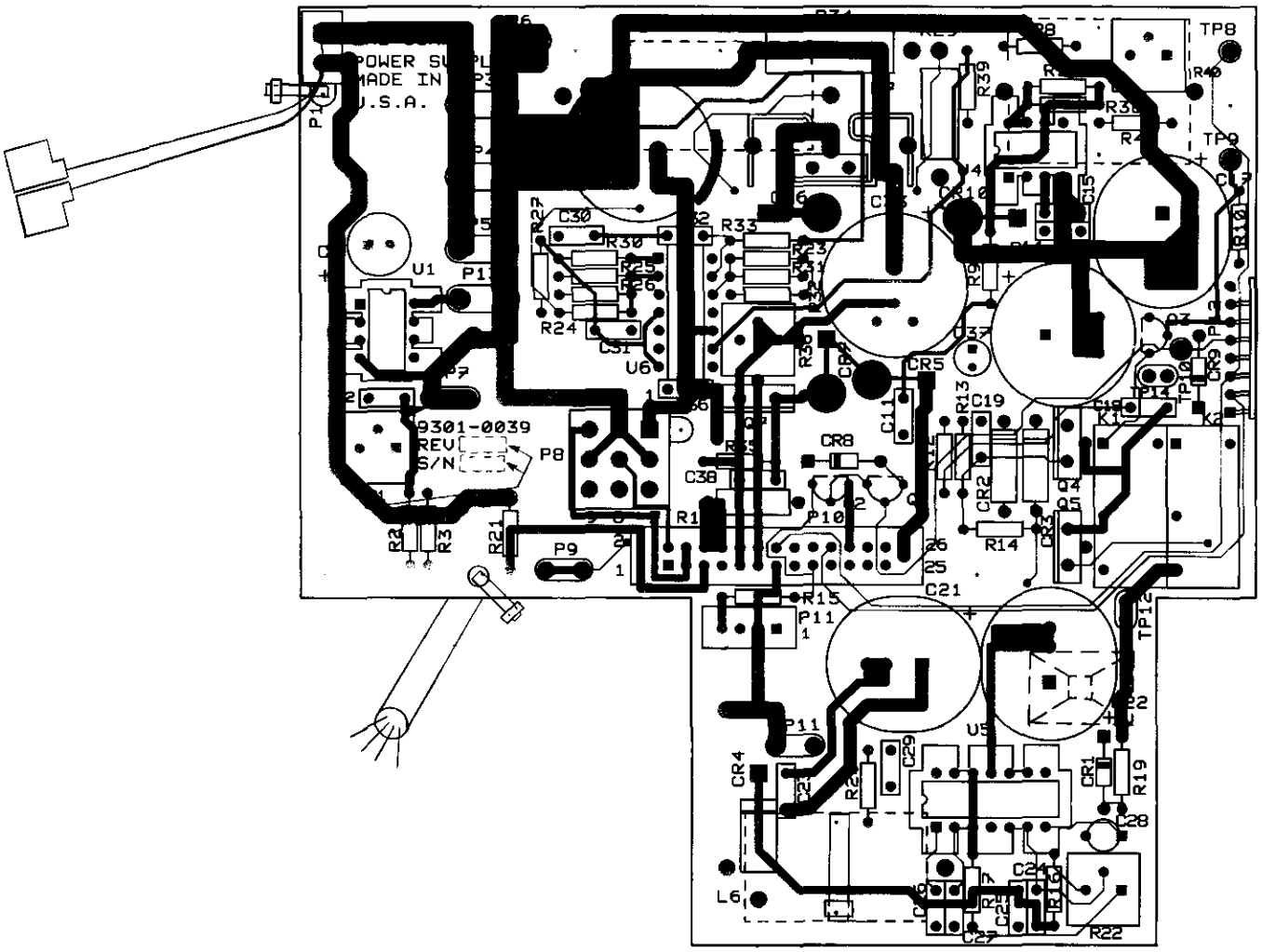
LIST OF DRAWINGS

Description	Drawing No.	Page
1. Charger	9301-0023	VIII-3
2. Power Supply	9301-0039	VIII-4
3. Power Supply Control	9301-0018	VIII-5
4. CPU	9301-0041	VIII-6
5. Defibrillator	9301-0047	VIII-7
6. Pacer	9301-0040	VIII-8
7. ECG	9301-0042	VIII-9
8. CRT	9301-0026	VIII-10
9. Input/Output	9301-0046	VIII-11



PAGE VIII - 3

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES .xx DECIMAL ± .01 .xxx DECIMAL ± .002 ANGLES ± FRACTIONS ± ALL SURFACES PARTS TO BE FREE OF BURRS AND SHARP EDGES	DR ANTAL CHK J.Shown 10/98 ENG PROJ	ZMI 325 VASSAR STREET CAMBRIDGE, MA 02139 TITLE CHARGER BOARD PCB ASSEMBLY
MATERIALS: SEE PARTS LIST 9301-0023-PL	MFG Q.C. CODE IDENT FINISH	SCALE: 2/1 SHEET 1 OF 1 SIZE D DWG. NO. 9301-0023 REV. G



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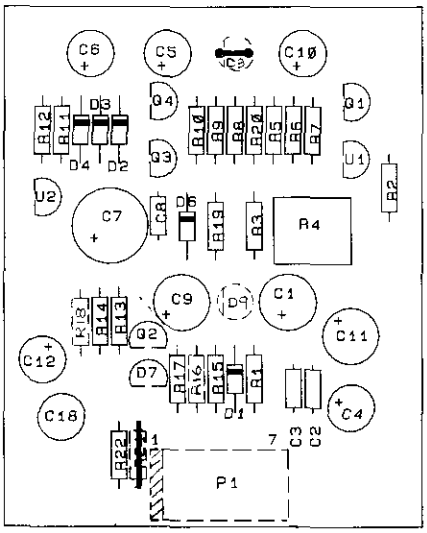
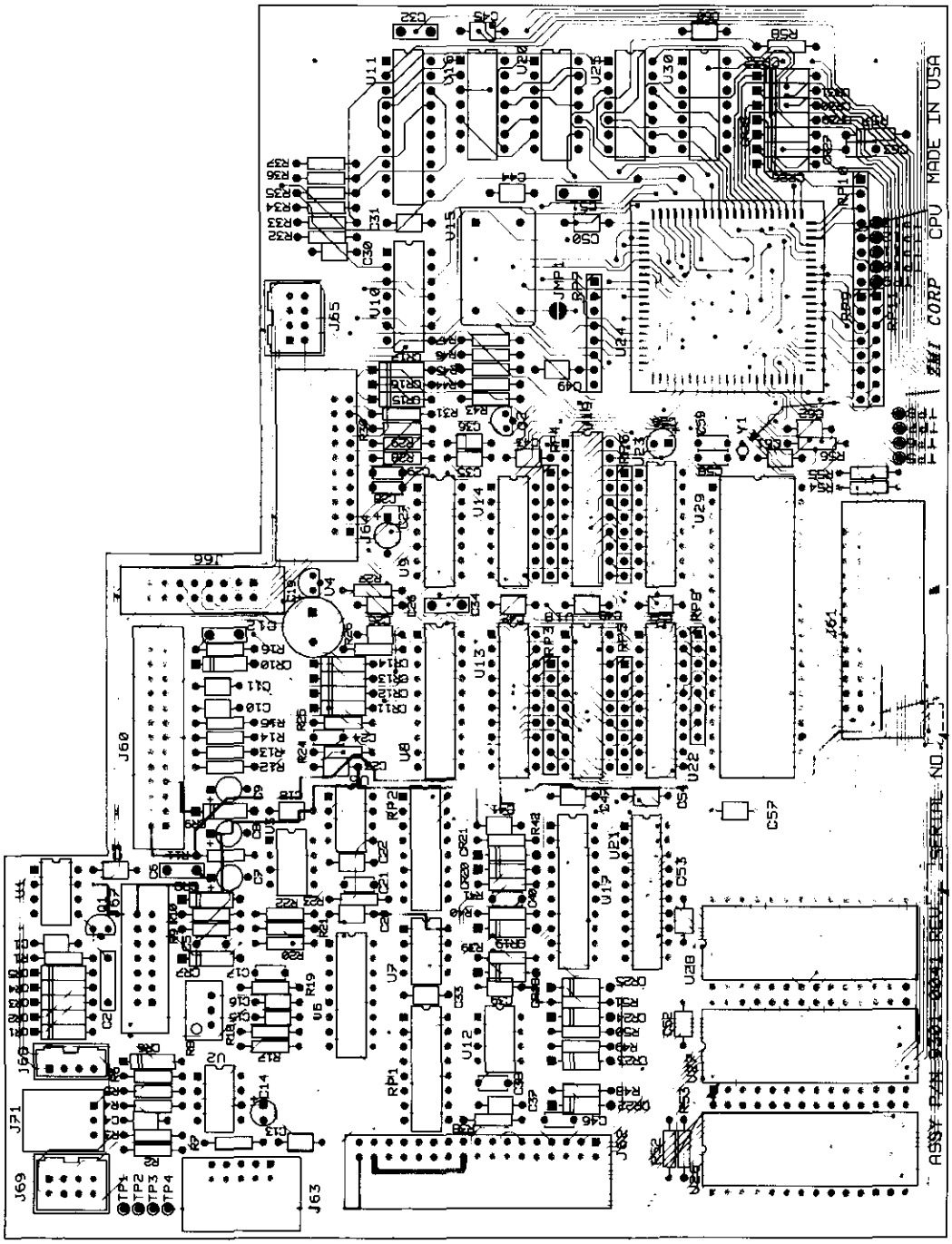
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE INCHES (MM) .XX ± ± .XXX ± ± △ ± ±	DRW A. Bradley	DATE 12/2/89	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801	
	CHK		TITLE ASSEMBLY, PCB POWER SUPPLY BD.	
	DES			
MATL	APP RWZ	2-19-90	D	DWG NO. 9301-0039 REV A
FINISH	FILE NO		SHT 1 OF 1	SCALE: 2:1



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES .XX DECIMAL ± .01 .XXX DECIMAL ± .002 ANGLES ± FRACTIONS ± ALL SURFACES PARTS TO BE FREE OF BURRS AND SHARP EDGES MATERIALS: SEE PARTS LIST	DRG'D DR ANTAL CHK J.Shown 10/88 ENG ENG PROJ. MFG Q.C. CODE IDENT FINISH	ZMI 325 VASSAR STREET CAMBRIDGE, MA 02139 TITLE POWER SUPPLY CONTROL TOP ASSEMBLY SCALE: 2/1 SHEET 1 OF 1 REV. C SIZE D DWG. NO. 9301-0018



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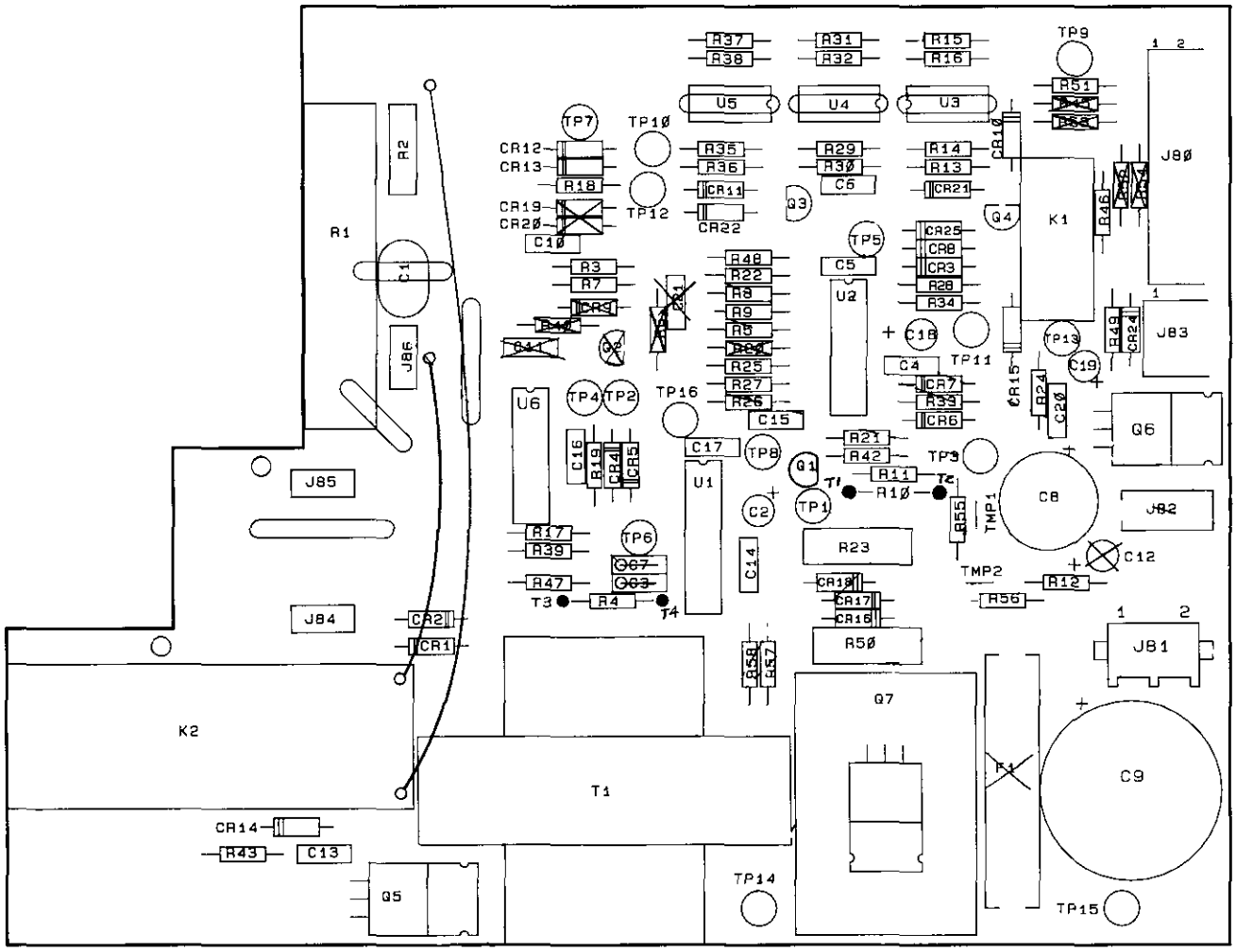
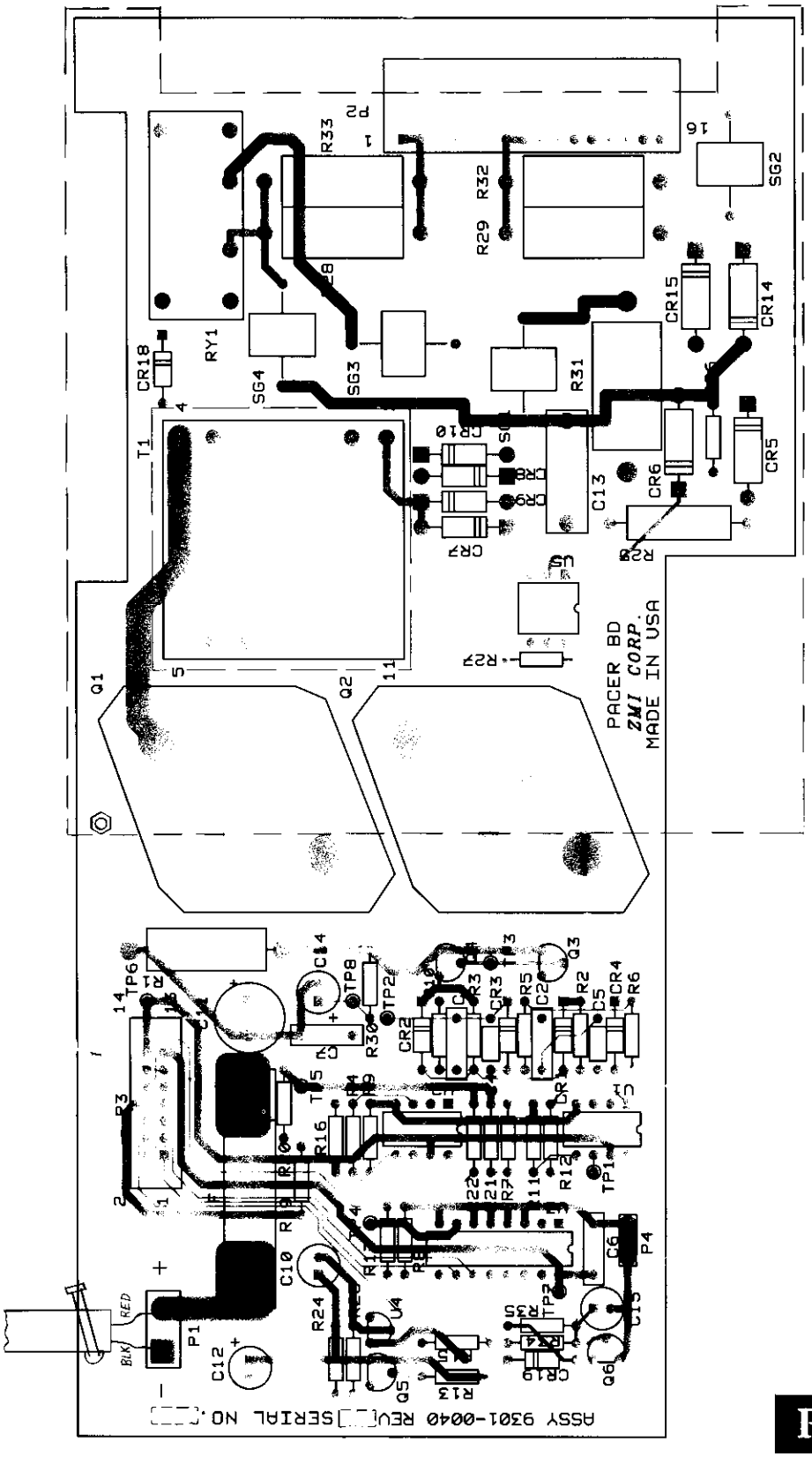
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE INCHES [MM] .XX ± ± .XXX ± ± △ ± ±	A. Bradley DRW	DATE 12/11/89	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801	
	GAF CHK	1/16/90	TITLE ASSEMBLY PCB CPU BD	
	GAF DES	1/16/90		
MATL SEE PL	APP	1-16-90	D	DWG NO. 9301-0041 REV C
FINISH				
	FILE NO		SHT 1 OF 1	SCALE: 2:2



PAGE VIII - 7

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES .XX DECIMAL ±.01 .XXX DECIMAL ±.002 ANGLES ± FRACTIONS ± ALL SURFACES PARTS TO BE FREE OF BURRS AND SHARP EDGES MATERIALS: SEE PARTS LIST	DRAWING: DR ANTAL; CHK; ENG; PROJ.; MFG; Q.C.; CODE IDENT; FINISH	ZMI 325 VASSAR STREET CAMBRIDGE, MA 02139 TITLE DEFIB BD TOP ASSEMBLY SCALE: 2/1 SHEET 1 OF 1 SIZE D DWG. NO. 9301-0047 REV. A



PAGE VIII - 8

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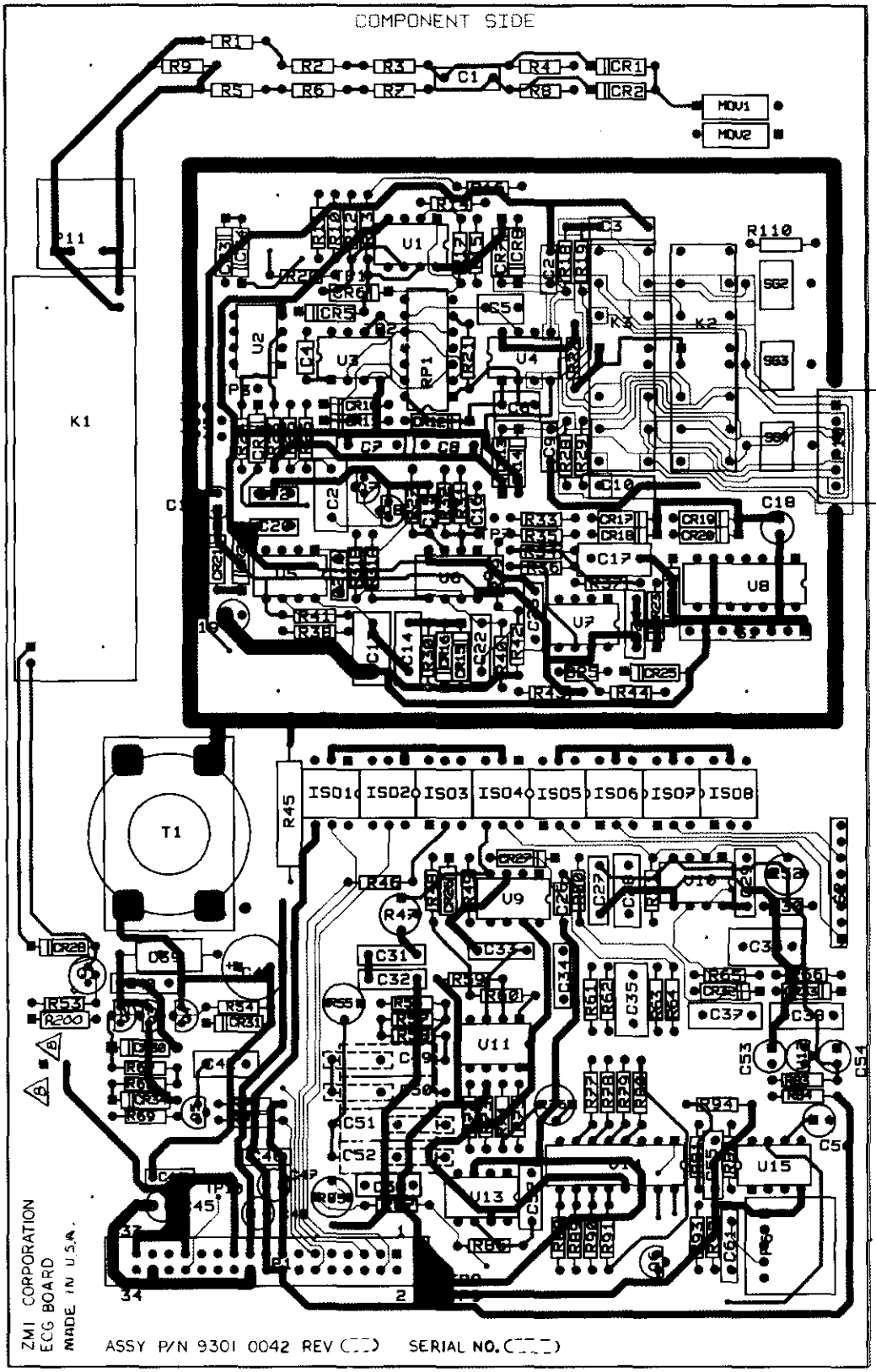
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE: INCHES [MM] .XX ± ± .XXX ± ± △ ± ±	DRW A Bradley	DATE 11.29.89	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801
	CHK		TITLE ASSEMBLY, PCB PACER BOARD
	DES		
MATL —/—	APP		
FINISH —/—			D DWG NO. 9301-0040 REV B
	FILE NO		SHT 1 OF 1 SCALE: 2:1



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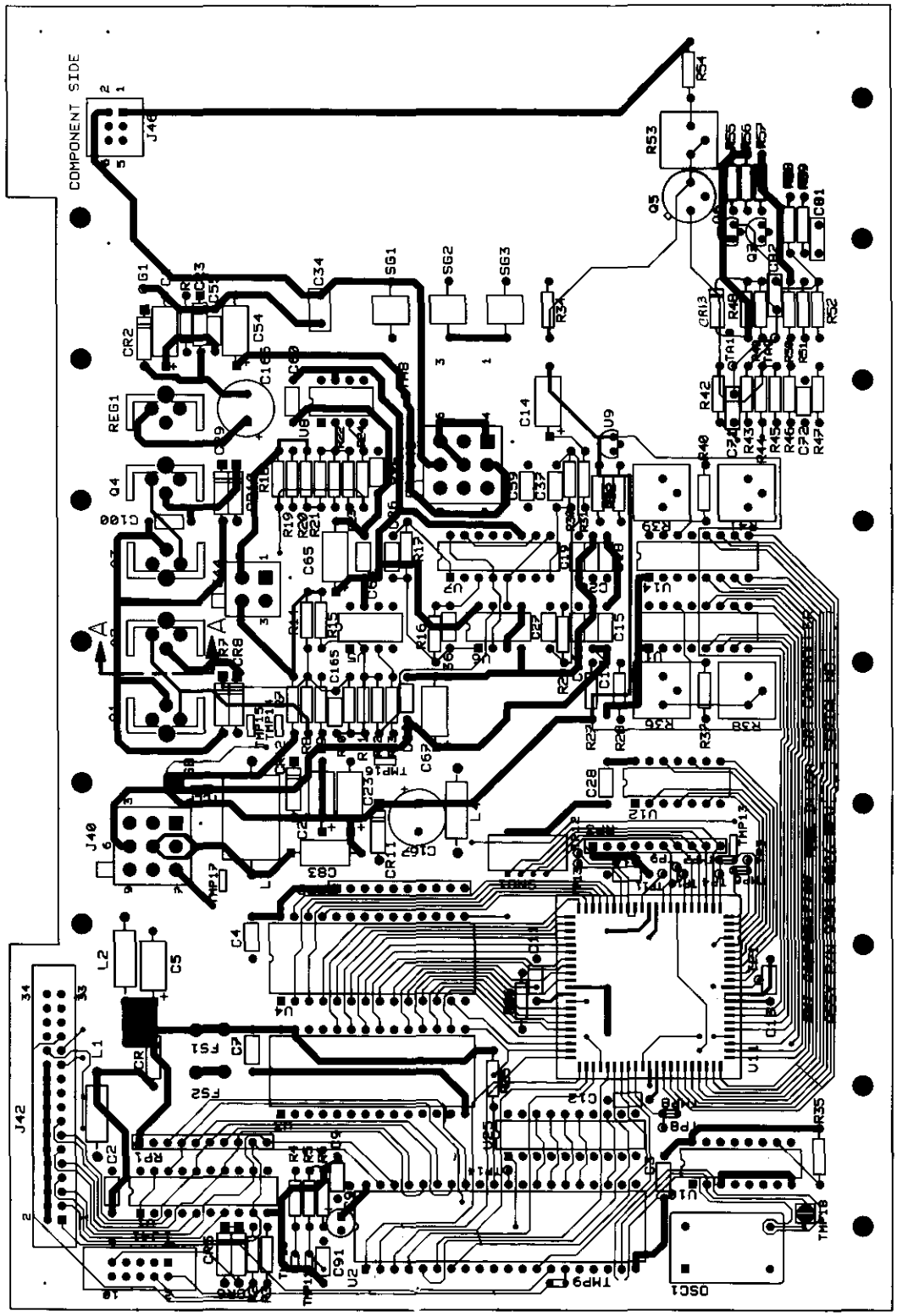
UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE (MM) INCHES .XX ± ± .XXX ± ± △ ± ±	DRW A. Bradley	DATE 8-23-89	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801
	CHK		TITLE PCB, ASSEMBLY ECG
MATL SEE P/L	DES RWG	8-31-89	D DWG NO. 9301-0042 REV B
FINISH	FILE NO		SHT 1 OF 1 SCALE: 2:1



PAGE VIII - 10

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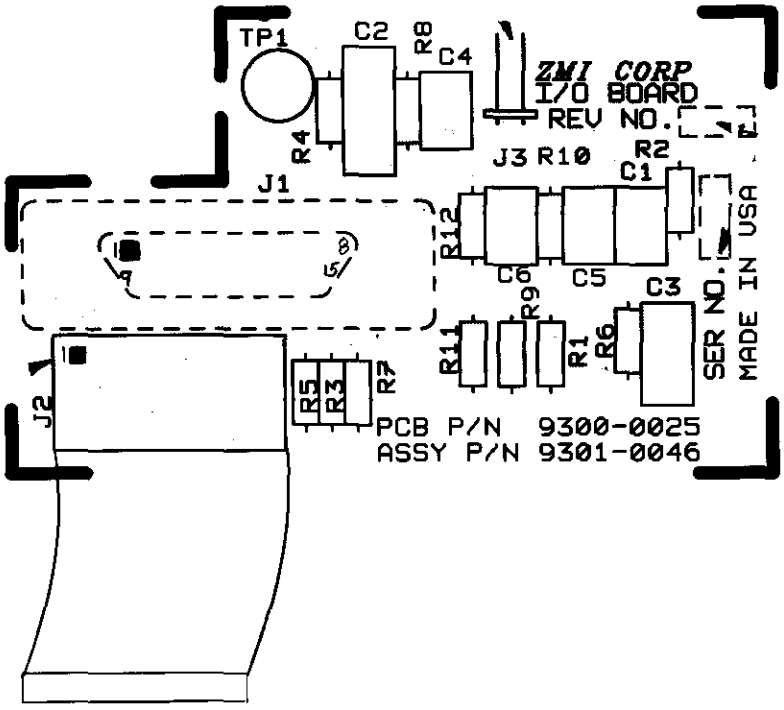
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES / TOLERANCES ARE: .XX ± ± .XXX ± ± △ ± ± MATL FINISH	DRW A. Bentley DATE 12.1.89; CHK; DES; APP 1-15-90; FILE NO	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801	TITLE ASSEMBLY, PCB CRT CONTROLLER BD; D; DWG NO. 9301-0026; REV B; SHT 1 OF; SCALE: 2:1



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UNLESS OTHERWISE SPECIFIED: TOLERANCES ARE INCHES [MM] .XX ± ± .XXX ± ± △ ± ±	A. Bradley DRW	DATE 11.29.89	ZMI CORPORATION 500 WEST CUMMINGS PARK WOBURN, MA 01801	
	GAF CHK	2/20/90	TITLE ASSEMBLY PCB INPUT / OUTPUT BOARD	
MATL	GAF DES	2/20/90		
	APP	2-22-90	C DWG NO. 9301-0046	REV B
FINISH	FILE NO		SHT 1 OF 1	SCALE: 2:1

IX

DISASSEMBLY PROCEDURES

This section is designed to assist in the removal and replacement of PD 1200 components. Be sure to observe anti-static precautions whenever the PD 1200 unit is open.

WARNING!

LETHAL VOLTAGES EXIST WITHIN THIS UNIT.
THE PD 1200 SHOULD BE SERVICED BY QUALIFIED PERSONNEL ONLY!

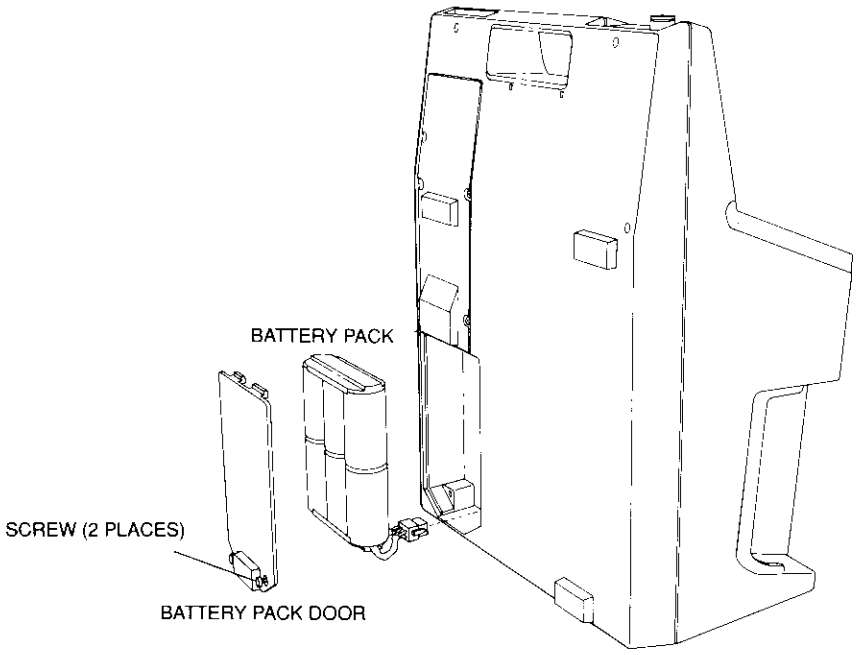
DISCONNECT BOTH THE AC POWER CORD AND THE BATTERY PRIOR TO DISASSEMBLY.

Be sure to remove the battery from the unit (see page IX-2) or disconnect it from the power supply (see page IX-5) before removing any components.

NOTE: Cable paths and connector locations should be noted prior to disassembly. If cables are run in locations other than those indicated by the manufacturer, the unit may not close properly.

LIST OF PROCEDURES

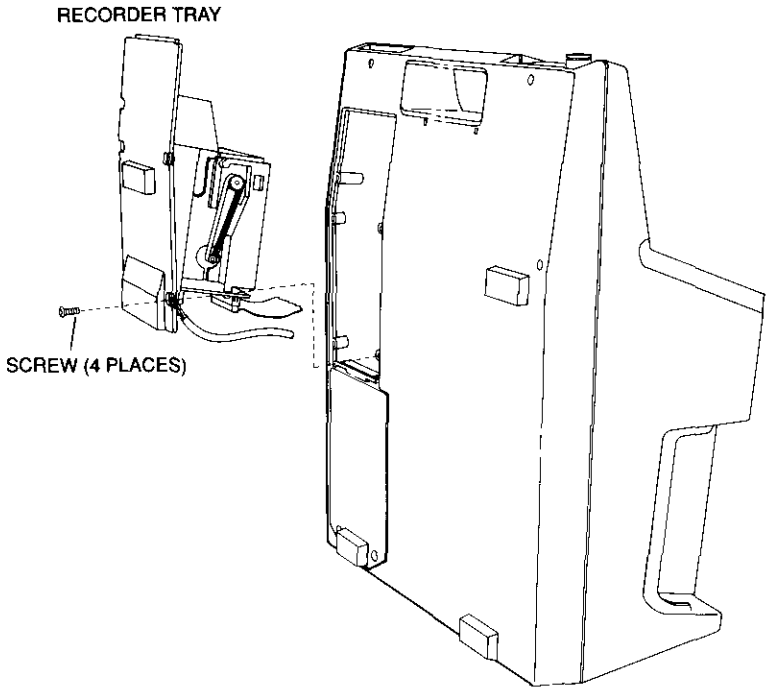
1. Removing the Battery IX-2
2. Removing the Recorder Module IX-3
3. Opening the PD 1200 ..... IX-4
4. Disconnecting Battery Power Internally IX-5
5. Removing the Pacer Board IX-7
6. Removing the CPU Board IX-9
7. Removing the ECG Board IX-11
8. Removing the Power Supply Module IX-12
9. Removing the Power Supply Control Board IX-13
10. Defibrillator Discharge Check IX-14
11. Removing the Defibrillator Module IX-15
12. Installing the Defibrillator Module IX-16
13. Removing the Charger Board IX-17
14. Removing the Front Bezel Switch Control Boards IX-18
15. Removing the CRT Board IX-20
16. Removing the CRT High Voltage Power Supply IX-21
17. Removing the Front Bezel IX-22
18. CRT Intensity Adjustment IX-23
19. CRT Alignment Procedure IX-23



1. REMOVING THE BATTERY

Tools Required:	Flat Blade Screwdriver

1. Unplug the AC power cord.
2. Stand the unit on end (as shown above) on its cord wrap (rear panel).
3. Loosen the two screws securing the battery compartment door.
4. Disconnect the battery cable and remove the battery.

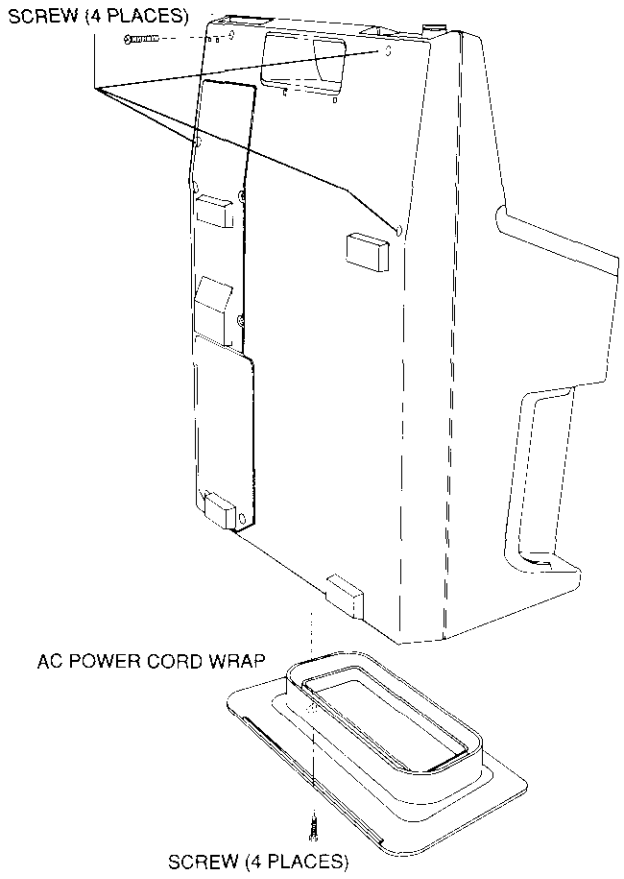


2. REMOVING THE RECORDER MODULE

Tools Required:	Phillips Head Screwdriver

1. Unplug the AC power cord.
2. Remove the strip chart paper from the front panel compartment.
3. Stand the unit on its cord wrap (rear panel).
4. Remove the four screws securing the Recorder module tray.
5. Pull the Recorder module out far enough to disconnect both the Power Supply and CRT board cables.
6. The Recorder is now free to be removed.

NOTE: To reinstall the recorder, perform these steps in reverse order.

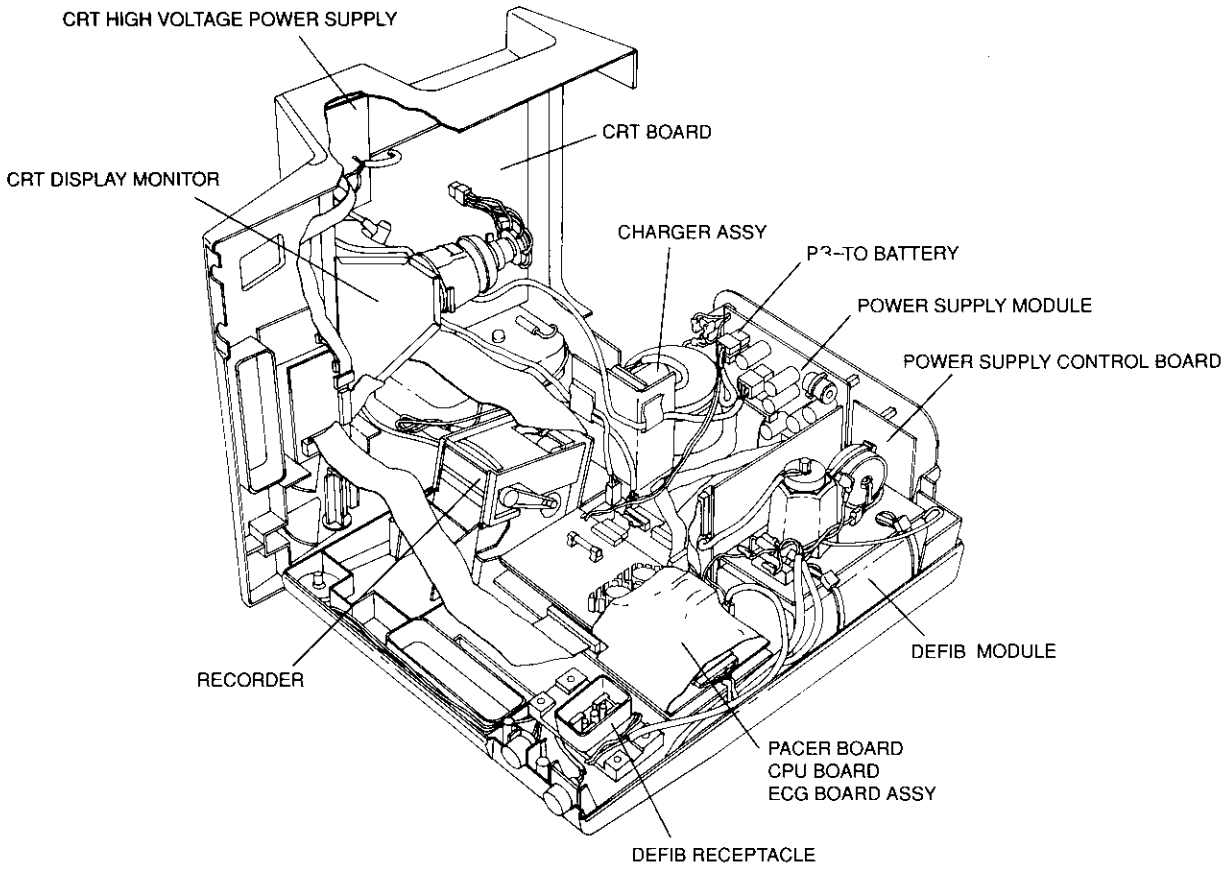


3. OPENING THE PD 1200

Tools Required:	Phillips Head Screwdriver

1. Remove the paper roll from the recorder unit.
2. Stand the unit on end (as shown above) on its cord wrap (rear panel).
3. Remove the four screws located on the unit's bottom.
4. Set PD 1200 on its bottom, leaving at least 15 inches of space to the left of the unit.
5. Remove the four screws securing the cord wrap to the unit. Remove the cord wrap.
6. Carefully separate the top and bottom halves of the case, by lifting the back of the top half and then the right side. The PD 1200 case should open easily. If you feel a snag, look inside to ensure that all internal cables are free.
7. Place the top half on its side to the left of the unit. Place a piece of cloth or cardboard under the top half to prevent the case from being scratched.

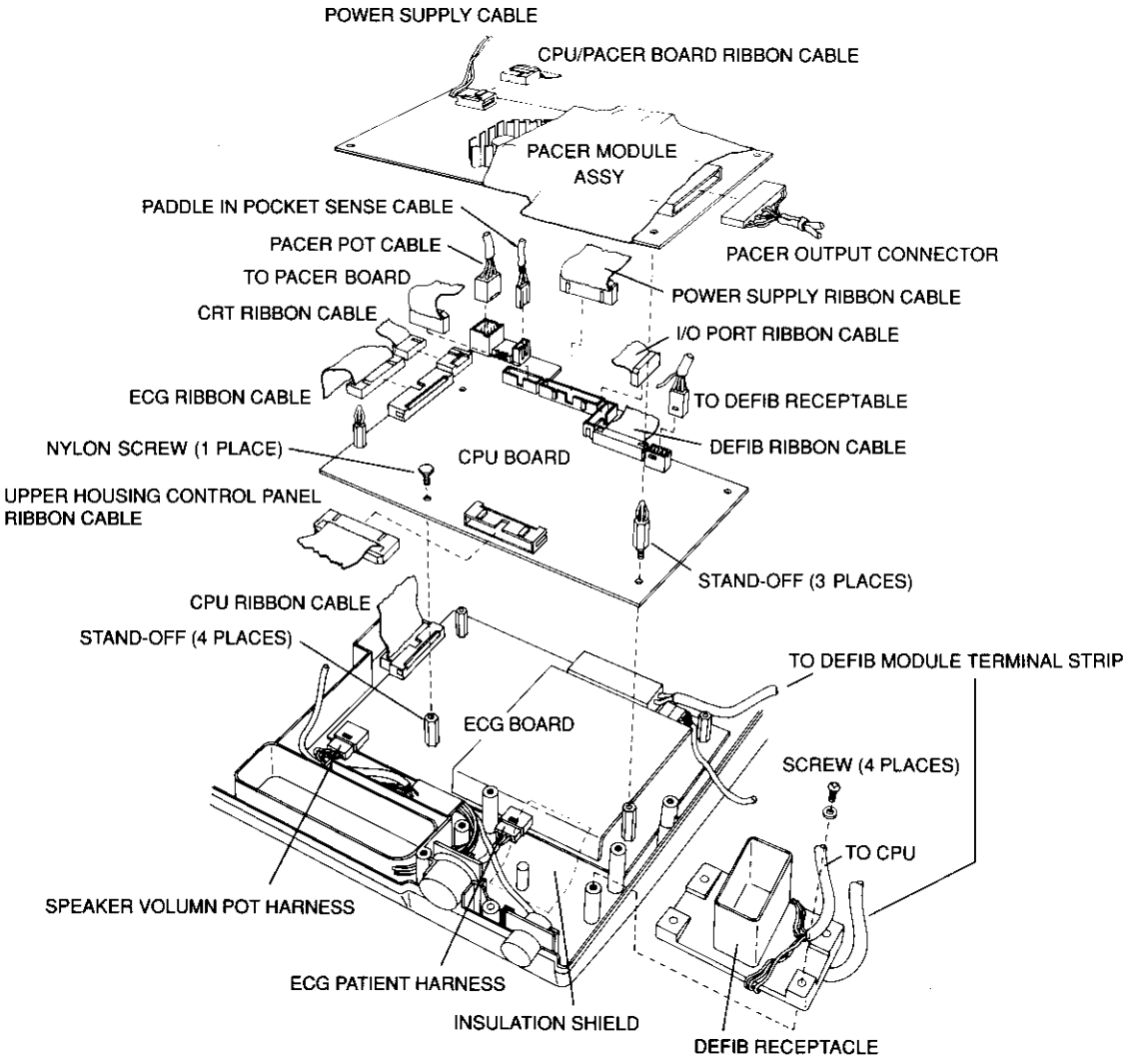
> **NOTE**: Cable paths and connector locations should be noted during disassembly. If cables are run in locations other than those indicated by the manufacturer, the unit may not close properly.



4. DISCONNECTING BATTERY POWER INTERNALLY

Tools Required:	Phillips Head Screwdriver

1. Open the unit (see page IX-4).
2. Disconnect P3 from the Power Supply board.
3. Battery power is now disconnected from the unit.

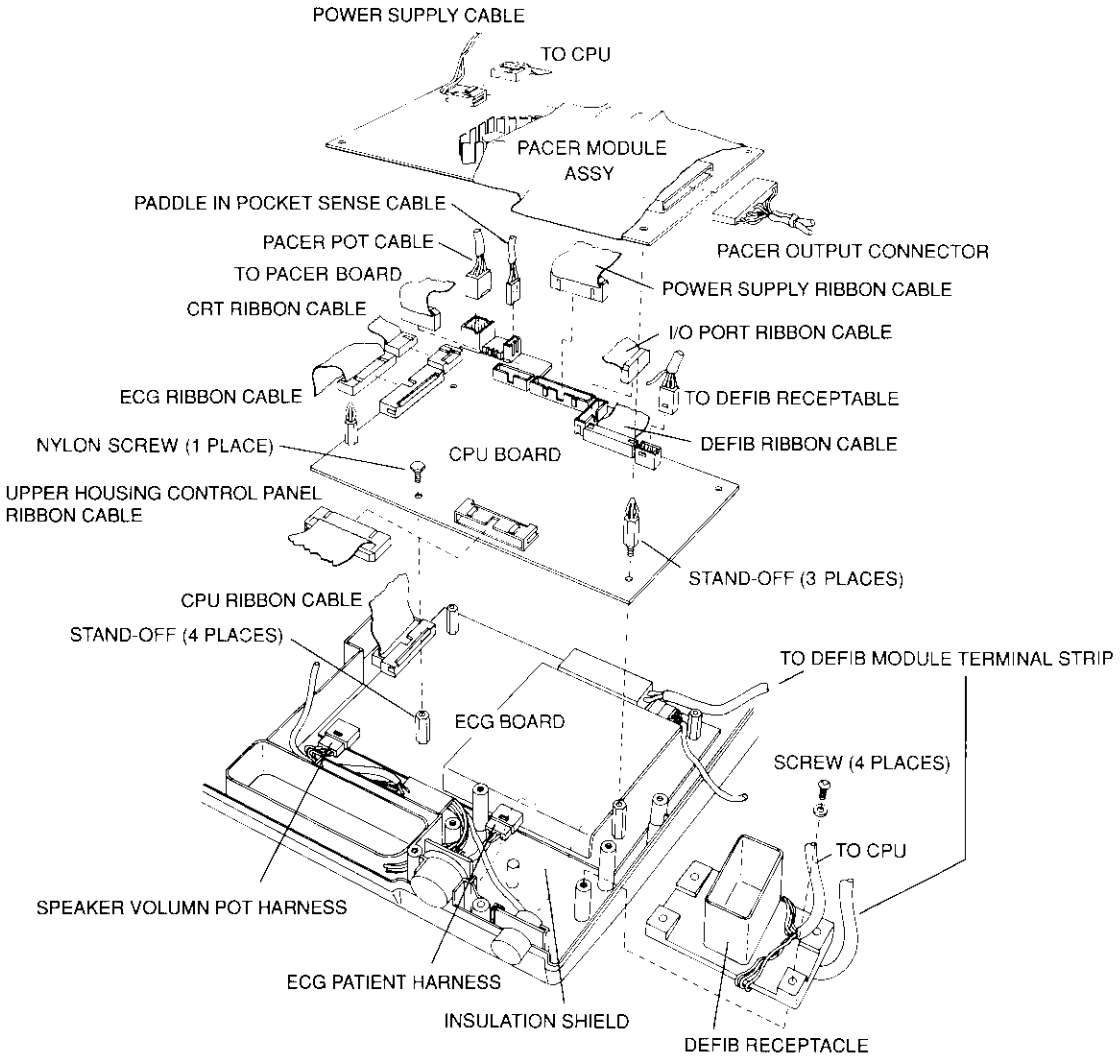

POWER SUPPLY CABLE
CPU/PACER BOARD RIBBON CABLE
PACER MODULE ASSY
PADDLE IN POCKET SENSE CABLE
PACER POT CABLE
TO PACER BOARD
PACER OUTPUT CONNECTOR
POWER SUPPLY RIBBON CABLE
CRT RIBBON CABLE
I/O PORT RIBBON CABLE
ECG RIBBON CABLE
TO DEFIB RECEPTABLE
NYLON SCREW (1 PLACE)
CPU BOARD
DEFIB RIBBON CABLE
UPPER HOUSING CONTROL PANEL RIBBON CABLE
STAND-OFF (3 PLACES)
CPU RIBBON CABLE
STAND-OFF (4 PLACES)
TO DEFIB MODULE TERMINAL STRIP
ECG BOARD
SCREW (4 PLACES)
TO CPU
SPEAKER VOLUMN POT HARNESS
ECG PATIENT HARNESS
INSULATION SHIELD
DEFIB RECEPTACLE

5. REMOVING THE PACER BOARD

Tools Required:	Phillips Head Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect Battery Power (see page IX-5).
3. Disconnect the:
   - Pacer output connector
   - Power Supply cable at the Power Supply
   - CPU/Pacer board ribbon cable at the Pacer board
4. Release the Pacer board from the stand-offs by pinching the top of each stand-off with your fingers.
5. Lift the Pacer board out.

NOTE: To reinstall the Pacer board, perform these steps in reverse order.

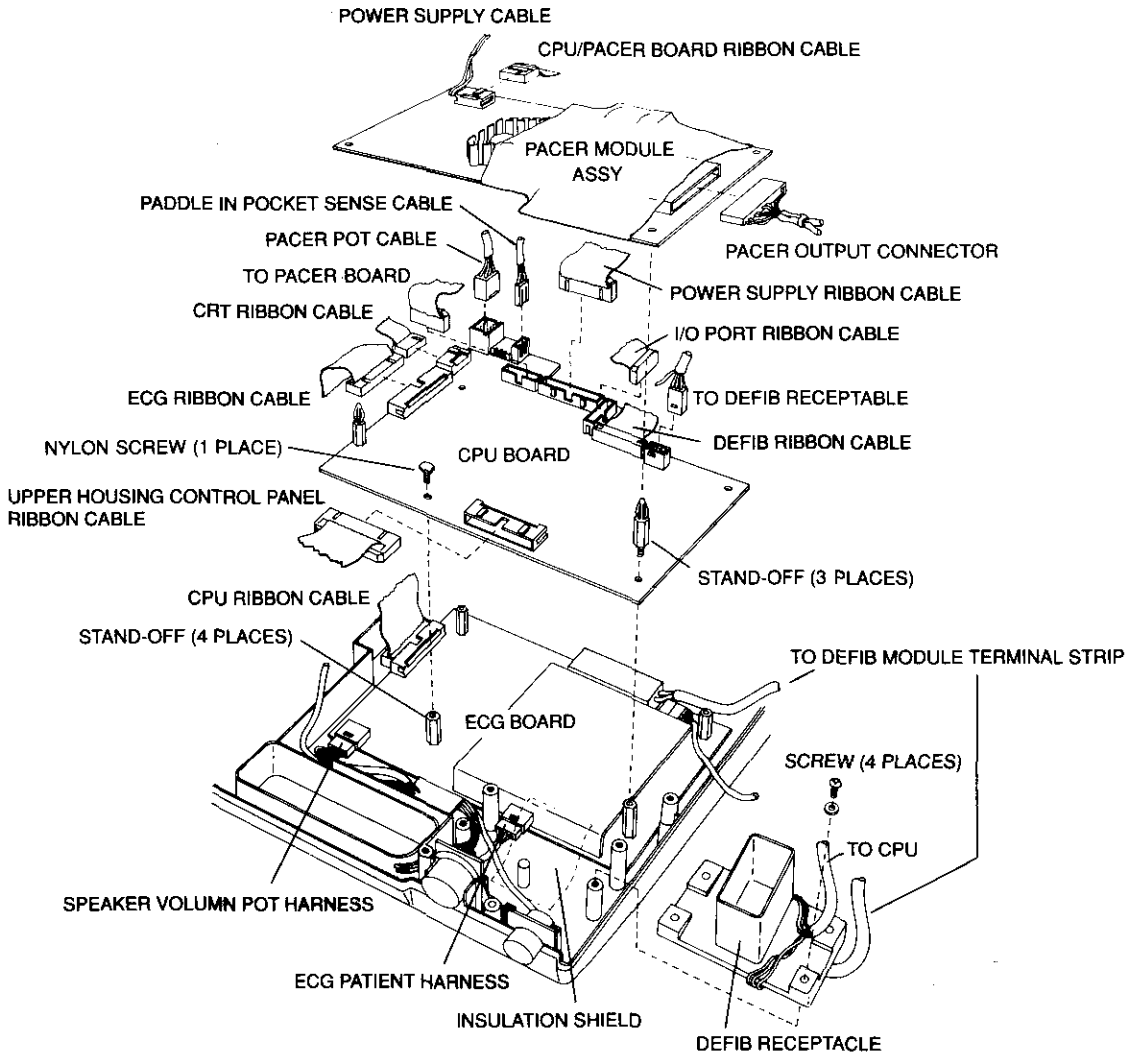

POWER SUPPLY CABLE
TO CPU
PACER MODULE ASSY
PADDLE IN POCKET SENSE CABLE
PACER POT CABLE
TO PACER BOARD
CRT RIBBON CABLE
PACER OUTPUT CONNECTOR
POWER SUPPLY RIBBON CABLE
I/O PORT RIBBON CABLE
ECG RIBBON CABLE
TO DEFIB RECEPTABLE
NYLON SCREW (1 PLACE)
CPU BOARD
DEFIB RIBBON CABLE
UPPER HOUSING CONTROL PANEL RIBBON CABLE
STAND-OFF (3 PLACES)
CPU RIBBON CABLE
STAND-OFF (4 PLACES)
TO DEFIB MODULE TERMINAL STRIP
ECG BOARD
SCREW (4 PLACES)
TO CPU
SPEAKER VOLUMN POT HARNESS
ECG PATIENT HARNESS
INSULATION SHIELD
DEFIB RECEPTACLE

6. REMOVING THE CPU BOARD

Tools Required:	Flat Blade Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect Battery Power (see page IX-5).
3. Remove the Pacer board (see page IX-7,.from step 3).
4. Disconnect the:
   - Defibrillator ribbon cable
   - I/O port ribbon cable
   - Power Supply ribbon cable
   - CRT ribbon cable at the CPU board
   - ECG ribbon cable
   - Paddle-in-Pocket sense cable
   - Pacer pot cable
   - Upper housing control panel ribbon cable
5. Remove the three nylon stand-offs that held the Pacer board. DO NOT remove the standoff adjacent to the ECG ribbon cable connector (refer to the diagram on page IX-7). Remove one nylon screw.
6. Lift the CPU board out.

NOTE: To reinstall the CPU board, perform these steps in reverse order.

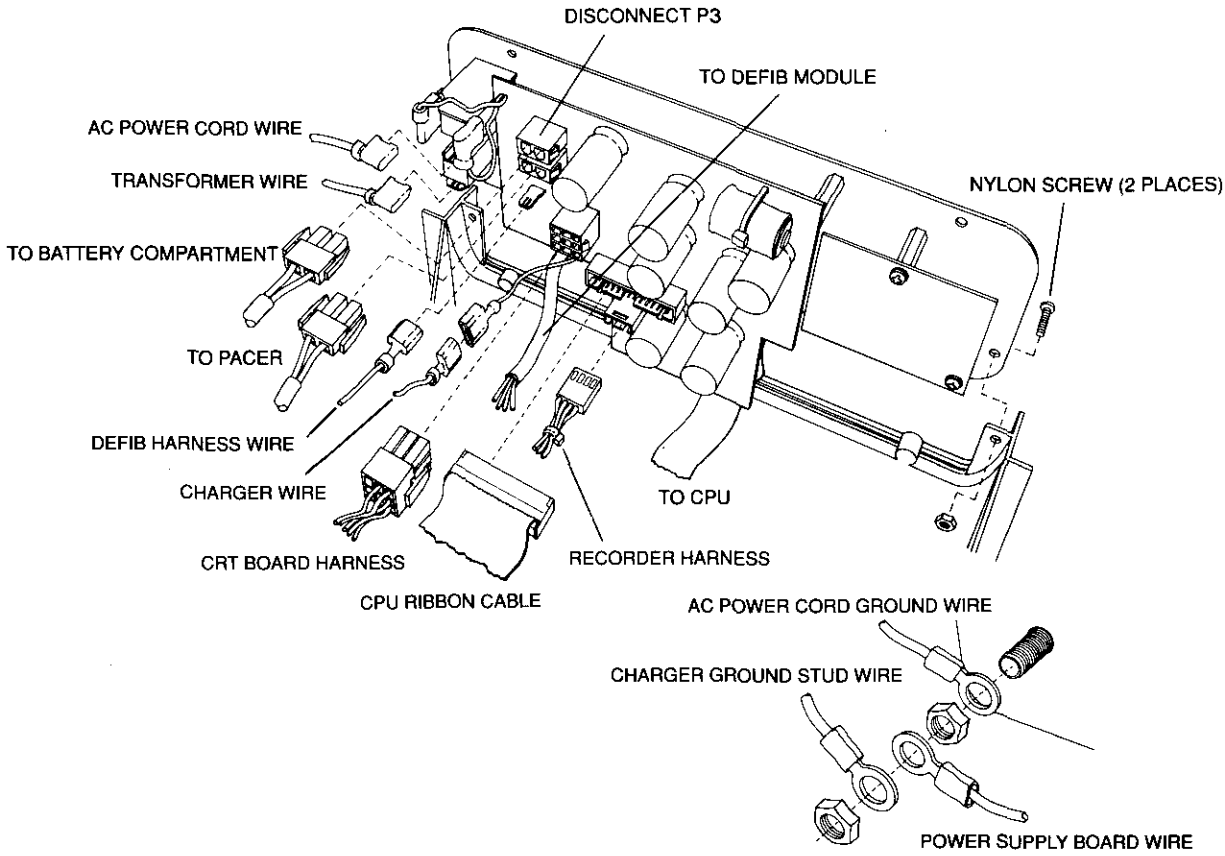

POWER SUPPLY CABLE
CPU/PACER BOARD RIBBON CABLE
PACER MODULE ASSY
PADDLE IN POCKET SENSE CABLE
PACER POT CABLE
TO PACER BOARD
CRT RIBBON CABLE
ECG RIBBON CABLE
NYLON SCREW (1 PLACE)
UPPER HOUSING CONTROL PANEL RIBBON CABLE
CPU RIBBON CABLE
STAND-OFF (4 PLACES)
SPEAKER VOLUMN POT HARNESS
ECG PATIENT HARNESS
INSULATION SHIELD
CPU BOARD
ECG BOARD
PACER OUTPUT CONNECTOR
POWER SUPPLY RIBBON CABLE
I/O PORT RIBBON CABLE
TO DEFIB RECEPTABLE
DEFIB RIBBON CABLE
STAND-OFF (3 PLACES)
TO DEFIB MODULE TERMINAL STRIP
SCREW (4 PLACES)
TO CPU
DEFIB RECEPTACLE

7. REMOVING THE ECG BOARD

Tools Required:	Adjustable Wrench Phillips Head Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Remove the Pacer board (see page IX-7, from step 3).
4. Remove the CPU board (see page IX-9, from step 4).
5. Remove the four screws securing the Defibrillator receptacle. Note the position of the insulation shield under the receptacle.
6. Disconnect the:
   - Speaker volume pot harness
   - ECG patient harness (under the patient harness)
   - CPU ribbon cable
7. Remove the four nylon/brass stand-offs that hold the CPU board.
8. Lift the ECG board out.

> **NOTE:** To reinstall the ECG board, perform these steps in reverse order. Be sure to position the insulation shield correctly under the Defibrillator paddle receptacle.

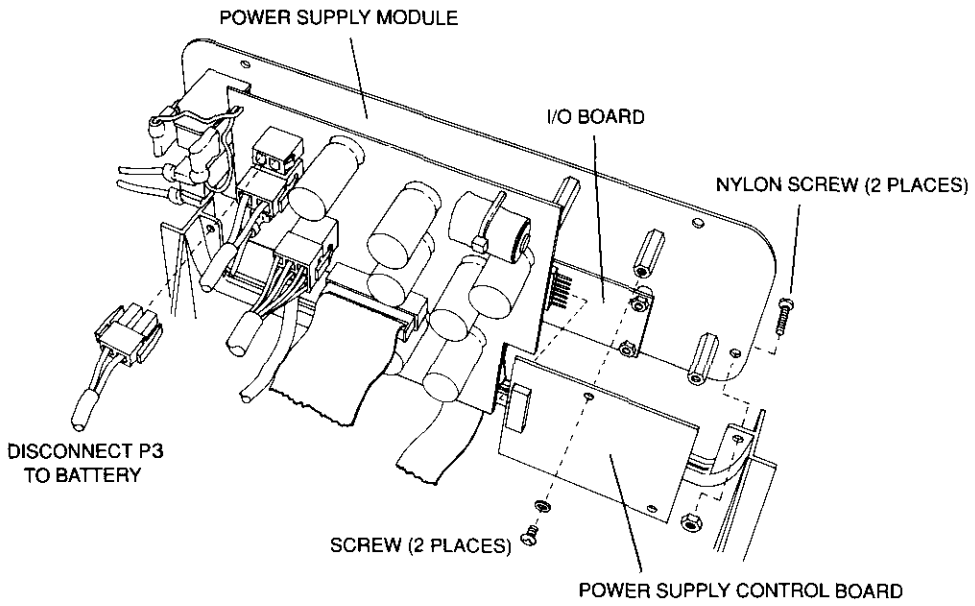


8. REMOVING THE POWER SUPPLY MODULE

Tools Required:	Flat Blade Screwdriver Adjustable Wrench

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Remove the nylon screw located at each side of the rear panel. Be careful not to drop the nuts into the unit.
4. Disconnect the:
   - AC power cord wire
   - Transformer wire
   - CRT board harness
   - Charger wire
   - CPU ribbon cable
   - Recorder harness
   - Defibrillator harness wire
   - Pacer harness
   - AC power cord ground wire
   - Charger ground stud wire
   - Power Supply board wire
5. Disconnect the two connectors on the Defibrillator module harness at the Defibrillator module.
6. Disconnect the ribbon cable attached to the I/O board at its CPU board connector.
7. Lift the Power Supply module out of the PD 1200 unit.

NOTE: To reinstall the Power Supply module, perform these steps in reverse order.

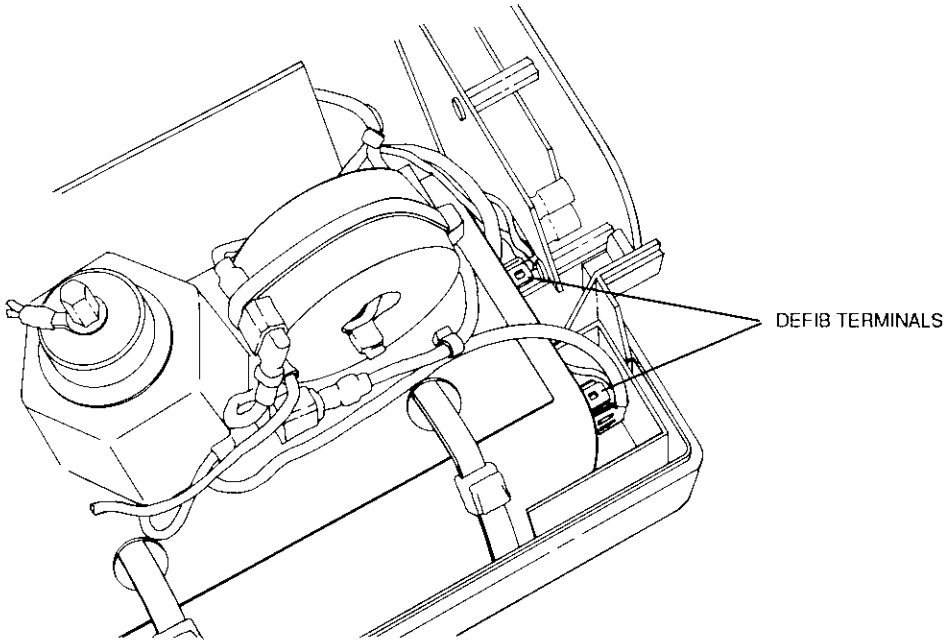


9. REMOVING THE POWER SUPPLY CONTROL BOARD

Tools Required:	Phillips Head Screwdriver Flat Blade Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Remove the nylon screw located at each side of the rear panel. Be careful not to drop the nuts into the unit.
4. Lift the Power Supply module slightly out of the instrument.
5. Remove the two screws/washers securing the Power Supply Control board.
6. Slide the Control board away from the Power Supply board. Be careful not to damage the seven pin connector between the two boards.

NOTE: To reinstall the Power Supply Control board, perform these *steps in reverse order.*



10. DEFIBRILLATOR DISCHARGE CHECK

WARNING

Use the high voltage voltmeter (capable of reading up to 6000 volts) to verify that the defibrillator capacitor has been properly discharged before doing any service to the defibrillator module.

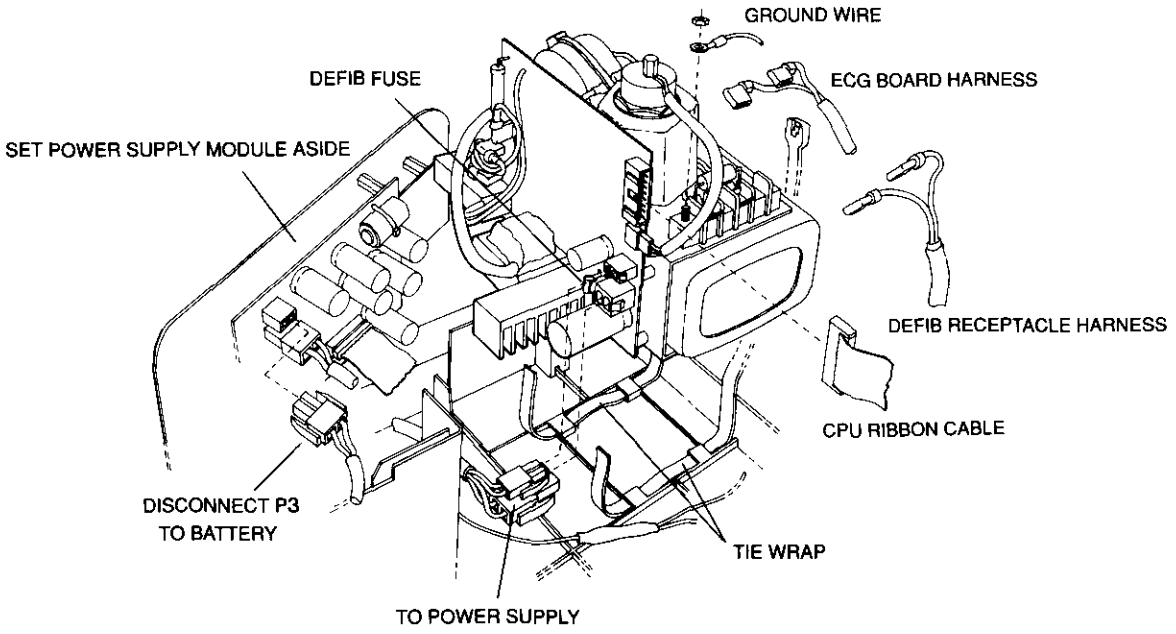
Tools Required: High Voltage Voltmeter

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Attach the voltmeter probes to the two terminals located on the rear of the capacitor. See illustration above.

WARNING

Do not position the probes near any other surfaces while in contact with the defibrillator terminals.

4. **If the meter indicates any voltage is present, do not service the assembly.**
   Contact ZMI Service Department immediately at 1-800-348-9011.

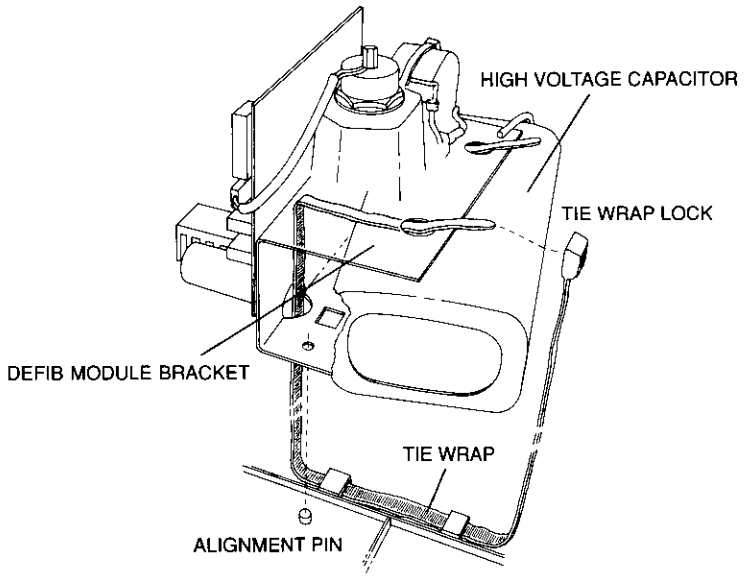


11. REMOVING THE DEFIBRILLATOR MODULE

Tools Required:	Flat Blade Screwdriver

WARNING: Check that the Defibrillator Capacitor is discharged before beginning!! Measure the defib cap with High Voltage Voltmeter probes. There should be no voltage on the cap.

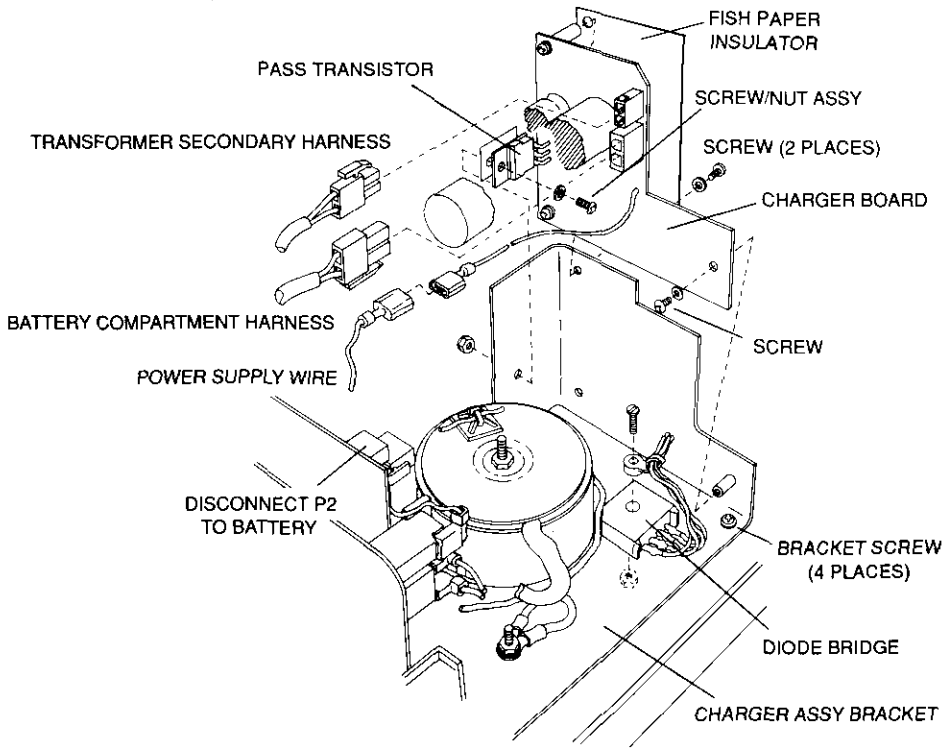
1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Lift (partially) the Power Supply module out of the unit (see page IX-12, steps 3 and 4 only).
4. Disconnect the:
   - two Power Supply harnesses
   - CPU ribbon cable
   - Defibrillator receptacle harness
   - ECG board harness
   - ground wire
5. Locate the two tie-wrap locks securing the Defibrillator module to the instrument case. Insert a small flat blade screwdriver into the bottom of the tie-wrap lock opening to disengage the lock. (The tie-wraps may be cut if you have replacements.)
6. The Defibrillator module is now ready to be removed. To release pressure on the tie-wraps, it is necessary to slightly pull the High Voltage Capacitor out of the Defibrillator module aluminum bracket. Tilt the module side adjacent to the instrument case up and lift the module out.



12. INSTALLING THE DEFIBRILLATOR MODULE

> It is recommended that all wires and cables in the instrument be secured out of the way during Defibrillator module installation.

1. Install two new tie-wraps into the slots in the PD 1200 case bottom. Position the tie-wrap lock approximately three inches up from the case bottom. Note the position of the serrations on the tie-wraps.
2. Note the location of the two pins molded in the PD 1200 case bottom and the corresponding holes in the aluminum bracket. The bracket must align with these pins at final installation.
3. Slightly pull the High Voltage Capacitor out of the aluminum bracket. Feed the two tie-wraps in through the semi-circular holes in the bracket bottom corner and out through the two circular holes in the bracket top.
4. Align the bracket over the two pins in the unit's case bottom.
5. Adjust the tie-wraps so that the locks will be positioned on the rounded edge of the High Voltage Capacitor when secured. Feed the tie-wraps through the locks and tighten. Cut and remove any excess that protrudes from the lock. (If the excess is not cut right down to the lock, the case may not close.)
6. Reconnect all cables, wires, and harnesses, following the paths and locations noted during disassembly.
7. Reinstall the Power Supply module.

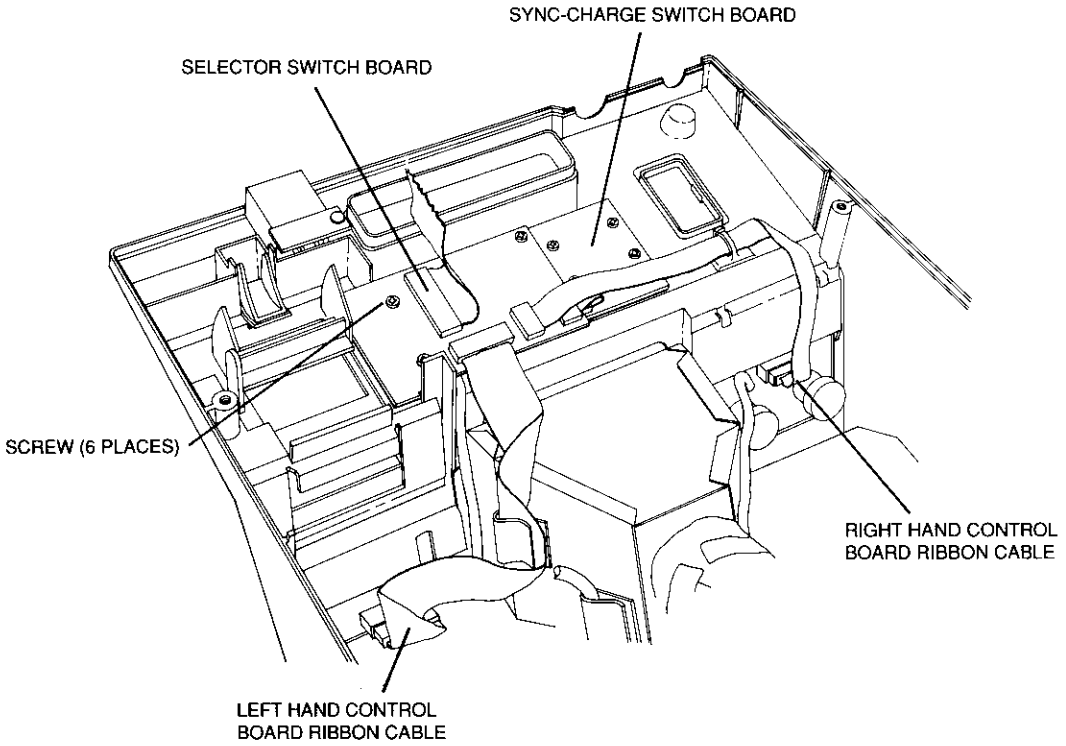


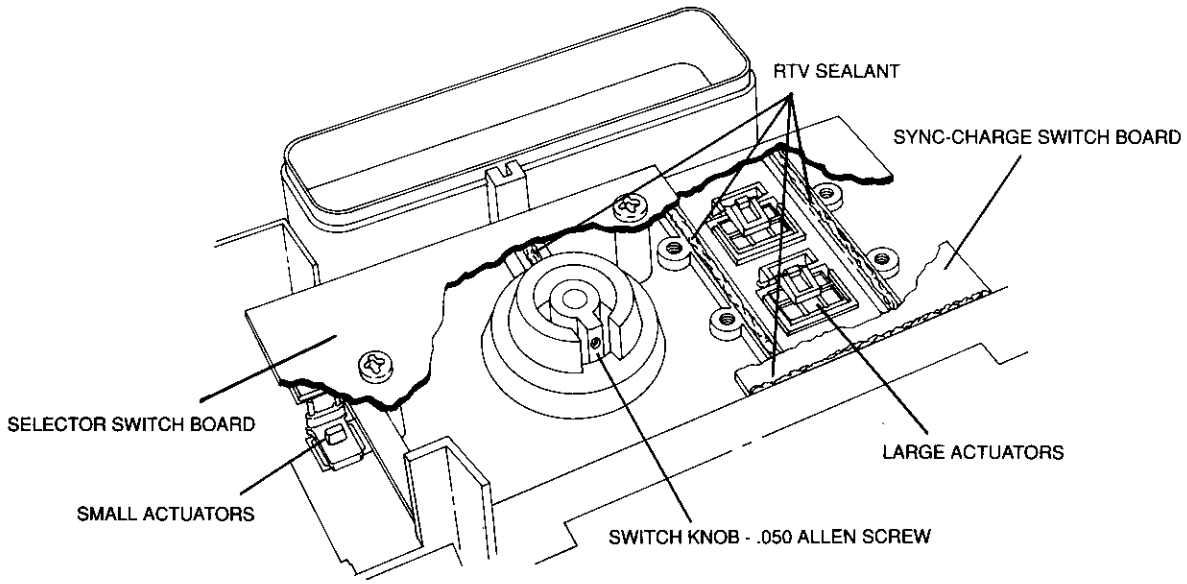
13. REMOVING THE CHARGER BOARD

Tools Required:	Phillips Head Screwdriver 1/4 Wrench

1. Open the PD 1200 unit (see page IX-4).
2. *Disconnect battery power (see page IX-5).*
3. Disconnect the:
   - Transformer secondary harness
   - Battery compartment harness
   - Power Supply wire
4. Remove the Charger bracket from the lower housing by removing the four screws/washers.
5. Remove the screw/nut securing the pass transistor to the Charger assembly aluminum bracket. Remove the screw/locknut holding the diode bridge of the Charger assembly bracket.
6. Remove the screw/washer located at the base of the Charger board.
7. Remove the two screws/washers located on the outside of the Charger assembly aluminum bracket.
8. Lift the Charger board out of the instrument.
9. Remove the two stand-offs still attached to the Charger board.

> **NOTE:** To reinstall the Charger board, install the two stand-offs to the new board first, then perform these steps in reverse order.


SYNC-CHARGE SWITCH BOARD
SELECTOR SWITCH BOARD
SCREW (6 PLACES)
RIGHT HAND CONTROL
BOARD RIBBON CABLE
LEFT HAND CONTROL
BOARD RIBBON CABLE

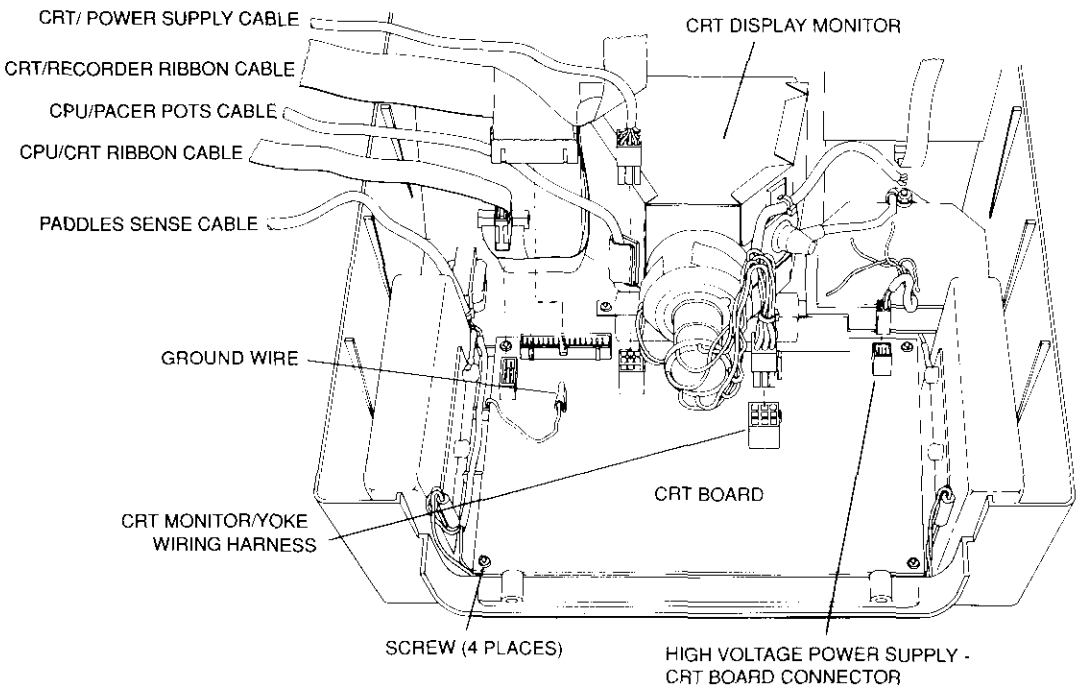

RTV SEALANT
SYNC-CHARGE SWITCH BOARD
SELECTOR SWITCH BOARD
LARGE ACTUATORS
SMALL ACTUATORS
SWITCH KNOB - .050 ALLEN SCREW

14. REMOVING THE FRONT BEZEL SWITCH CONTROL BOARDS

Tools Required:	Phillips Head Screwdriver Flat blade Screwdriver .050 Allen Wrench 1/2" Nut Driver X-acto Knife Silicone Rubber Sealant (RTV) Dikes or cutting pliers

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Disconnect the:
   - Recorder/CRT ribbon cable connector at the CRT board
   - CPU/CRT board ribbon cable connector at the CRT board
   - CPU/Pacer pots connector at the CPU board
   - I-Peak cable at the CPU board
4. Lay the unit's top half flat on the table.
5. Disconnect the two ribbon cables that connect the Selector Switch Board to the Right and Left Control Boards. Cut the plastic cable tie.
6. Turn the Selector Switch to the 7 or 10 joules position. Between the Selector Switch Board and the PD 1200 case is a cutout that allows access to the Allen set screw that secures the Selector Switch to the board. Loosen this screw with the Allen Wrench and remove the switch knob.
7. Remove the six (seven on some models) Philips head screws that secure the Selector Switch board and Sync Charge Switch board to the PD 1200 case.
8. With an X-acto knife, carefully cut the RTV sealant located where the Sync Charge Switch board abuts the PD 1200 case.
9. Remove the two boards. It may be necessary to pry (carefully) the Sync Charge Switch board away from the case with a flat blade screwdriver due to the adhesive properties of the RTV sealant. Also, the three Alarm Set buttons and small actuators located in the recorder paper compartment and attached to the Selector Switch board may disconnect from the board on removal. If this occurs, you must replace them as shown in the illustration detail.
10. Clean all remaining RTV sealant from the PD 1200's case noting the areas previously sealed. Apply a 1/16" wide bead of sealant to the same areas while reassembling.

> **NOTE:** To reinstall the switch boards, perform these steps in reverse order.

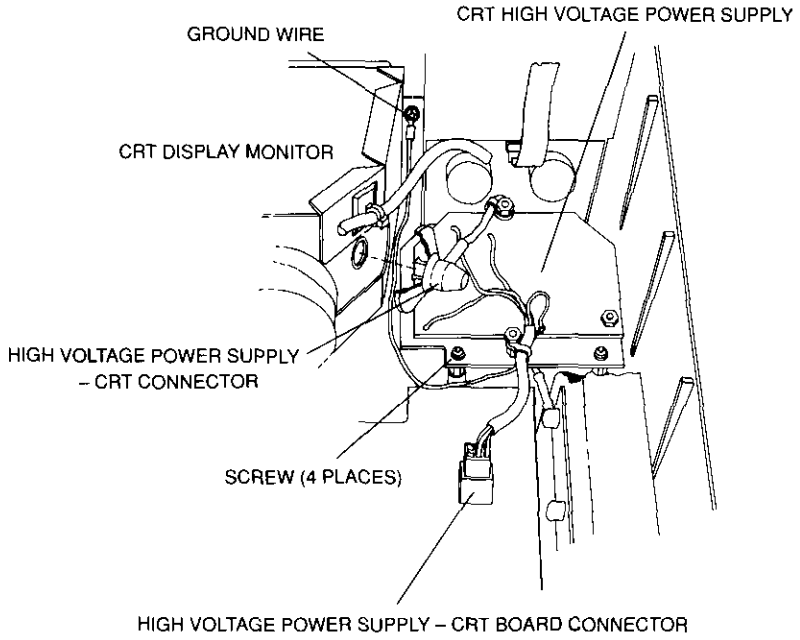


15. REMOVING THE CRT BOARD

Tools Required:	Phillips Head Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Disconnect the:
   - Recorder/CRT ribbon cable connector at the CRT board
   - CPU/CRT board ribbon cable connector at the CRT board
   - CPU/Pacer pots connector at the CPU board
   - Paddles Sense cable at the CPU board
4. Lay the unit's top half flat on the table.
5. Disconnect the High Voltage Power Supply/CRT board connector at the CRT board.
6. Disconnect the CRT monitor/yoke wiring harness at the CRT board.
7. Disconnect the CRT/Power Supply cable at the CRT board.
8. Disconnect the ground wire from the CRT ESD shield at the CRT board.
9. Remove the screw/washer located at each corner of the CRT board.
10. Lift the CRT board out.

NOTE: To reinstall the CRT board, perform these steps in reverse order.

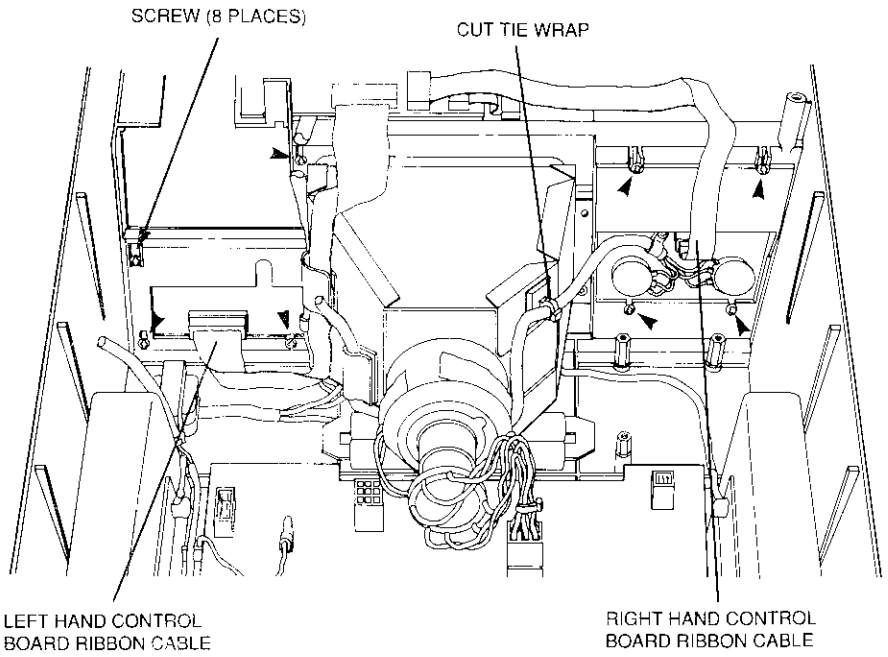

CRT HIGH VOLTAGE POWER SUPPLY
GROUND WIRE
CRT DISPLAY MONITOR
HIGH VOLTAGE POWER SUPPLY – CRT CONNECTOR
SCREW (4 PLACES)
HIGH VOLTAGE POWER SUPPLY – CRT BOARD CONNECTOR

16. REMOVING THE CRT HIGH VOLTAGE POWER SUPPLY

Tools Required:	Phillips Head Screwdriver Small Flat Blade Screwdriver

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Disconnect the:
   - Recorder/CRT ribbon cable connector at the CRT board
   - CPU/CRT board ribbon cable connector at the CRT board
   - CPU/Pacer pots connector at the CPU board
   - D-Peak cable at the CPU board
4. Lay the PD 1200 case's top half flat on the table.
5. Disconnect the High Voltage Power Supply/CRT board connector at the CRT board.
6. Disconnect the High Voltage Power Supply/CRT monitor connector at the CRT monitor. There are two metal clips inside the plastic shield securing the connector to the CRT monitor. Compress them together to disconnect the cable. Do this by inserting a small flat blade screwdriver under the plastic shield and pushing against one of the clips while pulling the connector away from the monitor.
7. Disconnect the ground wire located on the side of the CRT display monitor shield.
8. Remove the four screws/washers securing the High Voltage Power Supply board shield to the four stand-offs.
9. Lift the High Voltage Power Supply out.

> **NOTE:** To reinstall the CRT HV Power Supply, perform these steps in reverse order.



17. REMOVING THE FRONT BEZEL

Tools Required:	Long blade Phillips Head Screwdriver Dikes or cutting pliers

1. Open the PD 1200 unit (see page IX-4).
2. Disconnect battery power (see page IX-5).
3. Remove the CRT High Voltage Power Supply (see page IX-20).
4. Disconnect the two ribbon cables that connect the Left and Right Control boards to the Selector Switch board.
5. Cut the tie that secures the CPU/Pacer Pots Cable to the CRT Display shield.
6. Open the Paper Compartment door.
7. Remove the eight (8) screws securing the bezel to the PD 1200 case.
8. Remove the bezel.

NOTE: To reinstall the front bezel, perform these steps in reverse order.

Use these two procedures after replacing the CRT board or the CRT yoke.

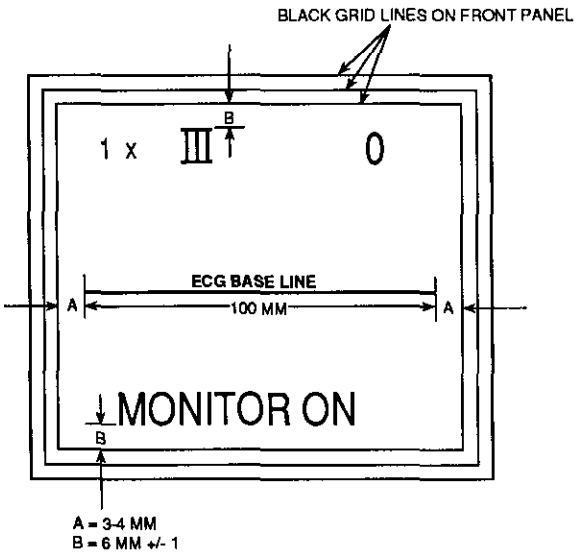
18. CRT INTENSITY ADJUSTMENT

Tools Required: Digital Voltmeter

1. Set the PD 1200 to the following configuration:
   - Size 1
   - Lead I
   - MONITOR ON
2. Connect the ECG cable to a simulator, with the simulator turned OFF.
3. Open the PD 1200 unit (see page IX-4).
4. Using the digital voltmeter, measure the voltage across R34 on the CRT board.
5. Adjust R53 to a setting of 85 mV +/- 5 mV.

19. ALIGNMENT PROCEDURE

1. Set the horizontal alignment first by adjusting the yoke as required.
2. Perform the left side "A" adjustment. Adjust R36 on the CRT board.
3. Perform the bottom "B" adjustment to MONITOR ON by adjusting R39 on the CRT board.
4. Perform the right side "A" adjustment. Adjust R38 on the CRT board.
5. Perform the top "B" adjustment to top of characters. Adjust R41 on the CRT board.



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REPLACEMENT PARTS

This section contains a listing of the replacement parts available for the PD 1200.

Replacement parts may be ordered through your sales representative, distributor, or directly from ZMI Corporation. When ordering parts, please provide the following information:

- *the PD 1200's model and serial number*
- Field Replaceable Unit part number
- Description of the replacement part

> ZMI reserves the right to substitute different parts to reflect modifications and improvements in PD 1200 circuitry and design.

To order directly from ZMI Corporation, address your request to:

ZMI Corporation	Telephone	(800) 348-9011
500 West Cummings Park		(617) 933-9150
Woburn, MA 01801	FAX	(617) 933-1807
Attention: Service Department	TELEX	95-1417

Current replacement part pricing is available from your sales representative or distributor. You may also contact ZMI's Service department for price quotations.

BILL OF MATERIAL CONTENTS

Charger Printed Circuit Board Assembly ..... 1002-0033 ..... X-3
CPU Printed Circuit Board Assembly ..... 9301-0041 ..... X-5
CRT Printed Circuit Board Assembly ..... 9301-0026 ..... X-9
Defibrillator Assembly ..... 1002-0104 ..... X-13
ECG Printed Circuit Board Assembly ..... 9301-0042 ..... X-17
Input/Output Printed Circuit Board Assembly ..... 9301-0046 ..... X-22
Pacer Module Assembly ..... 9301-0040 ..... X-23
Power Supply Printed Circuit Board Assembly ..... 9301-0039 ..... X-25
Power Supply Control Printed Circuit Board Assembly ..... 9301-0018 ..... X-28

FIELD REPLACEABLE UNITS

Description	Part Number
Cables for the PD 1200	
CPU to CRT	9500-0044
CPU to I/O board	9500-0024
CPU to Pacer	9500-0046
CPU to Power Supply	9500-0025
CRT board to CRT Tube	9500-0043
CRT to Power Supply	9500-0042
CRT to Recorder	9500-0036
Defibrillator to CPU	9500-0045
ECG to CPU	9500-0027
Power Supply to Defibrillator	9500-0037
Power Supply to Pacer	9500-0047
Recorder to Power Supply	9500-0032
Charger Printed Circuit Board Assembly	1002-0033
CPU Printed Circuit Board Assembly	9301-0041
CRT Printed Circuit Board Assembly	9301-0026
Defibrillator Assembly	1002-0104
Defibrillator Harness Assembly	1002-0010
ECG Printed Circuit Board Assembly	9301-0042
High Voltage Power Supply Assembly	1002-0108
Input/Output Printed Circuit Board Assembly	9301-0046
Pacer Module Assembly	9301-0040
Power Supply Printed Circuit Board Assembly	9301-0039
Power Supply Control Printed Circuit Board Assembly	9301-0018
Switch Assembly - Main	1002-0024
Switch Assembly - Left Hand	9301-0011
Switch Assembly - Right Hand	9301-0012
Thermal Recorder	9350-0002

CHARGER PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
0210-0053		IC MC 34060P U 201
0204-0183		TRANSISTOR Q203A, Q203B, Q204A, Q204BB,
0202-0008		TRANSISTOR PNP MPS-A56 TO-92 Q201
0200-0009		TRANSISTOR NPN MPS-A06 TO-92 Q200
0204-0006		TRANSISTOR FET RFP12P08 Q 202 [RCA]
0206-0090		RECTIFIER BRIDGE 4A 400V BR1
0206-0121		DIODE ZENER 1N5245B 15V CR 200
0140-0002		INDUCTOR 330 uh TOROID L 200
0210-0100		VOLTAGE REFERENCE LM385B-1.2 CR 202
0124-0456		CAP, 2700 uf C200
0124-0274		CAPACITOR 1000UF/25V C 204
0120-0125		CAPACITOR CERAMIC 1000pF C202
0120-0145		CAPACITOR .047uF CERAMIC C203
0120-0205		CAPACITOR .01uF 50V C201
0120-0335		CAPACITOR 1uF 50V CK06 C206
0100-1002		RESISTOR 10K0 1/4W CMF R 201, R203
0100-2212		RESISTOR 22k1 OHM 1/4W R200, R202, R212, R 206
0100-3161		RESISTOR 3K16 1/4W CMF R215
0100-5111		RESISTOR 5k11 1/4W CMF R204
0100-316R		RESISTOR 316 1/4W CMF R205
0106-0015		RESISTOR 180 OHM 1W 5or10% CARBON COMP R207
0106-0016		RESISTOR 330 OHM 1W 5or10% CARBON COMP R 208
0100-4751		RESISTOR 4K75 OHM 1/4W R210
0106-0003		RESISTOR 0.1 OHM 2W R213

CHARGER PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0108-0105		POT, 500 OHM R 216
0150-0615		CONNECTOR P1
9300-0032		PCB CHARGER BD
0206-0091		RECTIFIER ULTRAFAST 8A 100V CR 201
0100-2152		RESISTOR 21K5 1/4W CMF R214
0150-1513		TERMINAL, .250 FASTON FEMALE 22-18 awg P16 FLYING LEAD
0500-0284		WIRE YELLOW 22 awg 7x30 UL1430 P16 TO FLYING LEAD 18 1/2"
0150-0251		2 POS PINHEADER STRAIGHT ANGLE P2
0501-0001		CABLE TIE
0163-0176		SCREW #6-32 UNC-2B1/4" SS
0163-0037		WASHER, INTERNAL STAR #6 SS
0163-0381		WASHER NYLON #6
0160-0204		SPACER, 6-32 X 3/8 1/4" ROUND ALUM
9330-0021		INSULATOR, COIL CHARGER
0100-1004		RESISTOR 1 MEG 1% R 218
0100-422R		RESISTOR, 422 OHM RN55D R219
0120-0133		CAPACITOR .0047uF CERAMIC C207
0206-0001		DIODE 1N4148 CR207, CR 208
0500-0191		TUBING TEFLON #22 100' ROLL
0550-0010		THERMAL COMPOUND
0163-0152		SCREW, PAN HD PHILL 4-40 X 5/16 S/S
0163-0044		LOCKNUT 4-40 HEX NYLON INSERT
0165-0122		HEATSINK TO-220 VERT W/TAB .25 AAVID
0501-0001		CABLE TIE
0500-0282		WIRE RED 22 AWG 500' ROLL 8 1/2"
0500-0290		WIRE BLACK 22 awg 7x30 UL1430 9 1/4"

CPU PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
9300-0041	B	MAIN CONTROLLER PCB
0212-0210		80C31 MICROCONTROLLER U29
1002-0503		PROGRAMMED EPROM CPU U27
0212-0103		IC 8KX8 RAM 100ns U26
9212-0002		IC MAIN CONTROLLER GATE ARRAY U24
0212-0142		IC REAL TIME CLOCK MM58274 U23
0210-0101		VOLTAGE REFERENCE LM 385BZ-2.5 U4
0110-0234		RESISTOR SIP RP3,RP4,RP5,RP6,RP7,RP8,RP9,RP10,RP11
0206-0001		DIODE 1N4148 CR1,CR2,CR3,CR4,CR12,CR15,CR26,CR27,CR28,CR29 CR30,CR31,CR32,CR33
0210-0125		POWER MOSFET VQ1000J SILICONIX U23
0206-0055		DIODE SCHOTTKY 1N5711 CR13,CR14,CR17
0100-1002		RESISTOR 10K0 1/4W CMF R17,R18,R27,R37,R38,R51,R56
0100-1001		RESISTOR 1K00 1/4W CMF R6,R16,R30,R31,R32,R46,R54,R55,R58
0100-1003		RESISTOR 100K 1/4W CMF R5,R15,R19,R20,R24,R25,R57
0100-4221		RESISTOR 4.22K RN55D R11
0100-3833		RESISTOR 383K 1/4W CMF R21,R22
0100-100R		RESISTOR 100 1/4W CMF R35,R36,R52,R53
0100-8252		RESISTOR 82K5 1/4W CMF R47
0120-0335		CAPACITOR 1uF 50V CK06 C6,C12,C32,C34,C51
0210-0179		DIODE ARRAY FSA2510P U9,U10,U14,U30
0212-0272		IC 74HCT373N U18,U19,U22
0212-0253		IC 74HCT08N U20
0212-0251		IC 74HCT04N U16

CPU PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0209-0045		CRYSTAL NC26 FOX FREQ. 32.76 Y1
0212-0269		IC 74HCT273N U13
0210-0206		IC PMI 7528GP U8
0210-0110		DUEL OPAMP LF442CN U1,U3,U6
0210-0018		PMI REF02EZ U2
0206-0108		DIODE ZENER 1N5232B 5.6V CR5,CR16
0206-0167		DIODE ZENER 1N4745A 16V CR7,CR8,CR9,CR10
0200-0001		TRANSISTOR 2N3904 Q2
0110-0538		RESISTOR 20k OHM DIP 16 PIN RP2
0110-0547		RESISTOR 100k OHM DIP 16 PIN RP1
0100-5112		RESISTOR 51k1 OHM 1/4W R9,R28,R29
0100-249R		RESISTOR 249 OHM 1% R39,R40,R41,R42,R48,R49
0120-0612		CAP 0.1uF 50V CERAMIC 20% AXIAL CONFOM C1,C3,C4,C10,C11,C13,C15,C16,C18,C20,C22, C23,C25,C26,C30,C31,C33,C35,C36,C37,C39 C41,C42,C43,C44,C45,C47,C48,C49,C50,C52, C53,C54,C55,C60,C61,C62
0120-0333		CAPACITOR .68uF 50V CK06 C63
0124-0013		CAPACITOR TANT 10UF 25V C8,C7,C9,C27,C56
0150-0656		HEADER 34 PIN RT ANG DUAL ROW J62
0210-0119		IC A/D CONV ADC0844BCN U17
0120-0143		CAPACITOR 33nF CERAMIC C5,C17
0150-0651		HEADER 10 PIN RT ANG DUAL ROW J63
0150-0654		CONNECTOR J64
0210-0128		MULTIPLEXER DG508ACJ U5
0124-0700		CAPACITOR 220UF 6.3V NICHICON C19

CPU PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0209-0060		OSCILLATOR, 12 MHZ OSCILLATOR MODULE U15
0100-1963		RESISTOR, 196K R14,R12
0100-3163		RESISTOR 316K RN55D R10
0100-36R5		RESISTOR 36.5 OHM 1/4W 1% R33
0120-0027		CAPACITOR, CERAMIC C24,C40
0120-0131		CAPACITOR .0033UF CERAMIC C38
0150-1581		SOCKET/GARRY FOR U27
0150-1582		SOCKET/GARRY U29
0206-0065		DIODE FAIRCHILD#FDH300 CR6
0150-0088		HEADER 40 POS. TP-1 TO TP-4
0150-0151		3 POS RA HEADER J71
0150-0675		HEADER, 26 PIN STR. RIBBON J60
0150-0672		CONNECTOR J67
0150-0673		CONNECTOR j66
0150-1101		CONNECTOR DUEL ROW 8 PIN J69, J65
0150-0052		HEADER, SHROUDED 4 POS. STR. J68
0100-1473		RESISTOR 147K 1/4W CMF R43
0100-383R		RESISTOR 383 1/4W CMF R26,R44
0100-178R		RESISTOR 178 1/4W CMF R34
0100-2372		RESISTOR 23.7K RN55D R13,R45
0100-5113		RESISTOR 511k OHM 1/4W R2,R3
0100-2003		RESISTOR 200k OHM 1/4W R4
0100-6812		RESISTOR 68K1 1/4W CMF R23
0120-0105		CAPACITOR 22pF C46,C58,C59

CPU PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0120-0129		CAPACITOR .0022uF CERAMIC C21
0210-0007		OPAMP, TL072BCP U7,U12
0206-0110		DIODE ZENER 1N5234 CR11
0108-0058		POTENTIOMETER 5 K R8
0100-162R		RESISTOR, 162 OHM RN55D R1
0204-0258		MOSFET, BS 107 N CHANNEL Q1
0122-0094		CAPACITOR FILM .33uF C2
0206-0079		DIODE, SB140 SCHOTTKY F-126 PKG. CR18,CR19,CR20,CR21,CR22,CR23,CR24,CR25
0124-0001		CAPACITOR TANF 1 UF 25V 20% C14
0120-0017		CAPACITOR CERAMIC 220PF C57
0212-0130		74HCT241 OCTAL TRI-STATE BUFFER U11
0212-0125		IC TRI-STATE BUFFER U21
0150-0655		HEADER 26 PIN J61
0120-0119		CAP CERAMIC CK05 10% 200V RADIAL C28,C29
0100-100R		RESISTOR 100 1/4W CMF R7
0150-0188		HEADER 40 POS TP5 TO TP13
0550-0043		RTV, SILASTIC 738

CRT PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
0100-1001		RESISTOR 1K00 1/4W CMF R13, R14, R24
0100-1002		RESISTOR 10K0 1/4W CMF R4, R5, R25, R26, R34, R35, R48, R49
0100-1004		RESISTOR 1 MEG 1% R21
0100-100R		RESISTOR 100 1/4W CMF R3,R2
0100-110R		RESISTOR, 110 OHM RN55D R19
0100-1211		RESISTOR 1K21 RN55D R27,R32
0100-1332		RESISTOR, 13.3K RN55D R29
0100-1471		RESISTOR 1K47 1/4W CMF R31
0100-1472		RESISTOR 14K7 1/4W CMF R59, R46
0100-1622		RESISTOR 16.2K RN55D R12
0100-1962		RESISTOR 19.6K RN55D R16,R17,R30
0100-2152		RESISTOR 21K5 1/4W CMF R6
0100-2153		RESISTOR 215K 1/4W CMF R50
0100-2611		RESISTOR 2K61 1/4W CMF R20, R1
0100-3162		RESISTOR 31K6 1/4W CMF R23, R55, R56, R54
0100-4221		RESISTOR 4.22K RN55D R28,R33,R43
0100-4222		RESISTOR 42K2 1/4W CMF R51
0100-46R4		RESISTOR, 46.4 OHM RN55D R9
0100-5621		RESISTOR 5K62 1/4W CMF R57
0100-8251		RESISTOR 8K25 1/4W CMF R47
0100-8253		RESISTOR 825K 1/4W CMF R10
0100-825R		RESISTOR 825 1/4W CMF R15,R22,R37,R40
0100-9091		RESISTOR, 9.09K RN55D R52
0106-0009		RESISTOR R7, R18

CRT PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0108-0007		TRIMPOT 5K OHM R36,R38,R39,R41
0110-0330		RESISTOR SIP 4K7 10 PIN COMMON BUS RP1
0110-0334		RESISTOR NETWORK 10KX8 RP02,RP03
0120-0013		CAPACITOR CERAMIC 100PF C27
0120-0015		CAPACITOR CERAMIC 150 PF C16, C19, C37
0120-0017		CAPACITOR CERAMIC 220PF C91
0122-0002		CAPACITOR FILM 10NF C36
0120-0105		CAPACITOR 22pF C82
0120-0107		CAPACITOR 33pF C81
0120-0331		CAPACITOR .47uF CERAMIC C71
0120-0460		CAPACITOR 0.1 uFd 200v C34
0120-1027		CAPACITOR, CERAMIC AXIAL 0.1uf +- 20% C2,C3,C4,C7,C9,C10,C11,C12,C13,C15,C17 C18,C20 C28,C55,C59,C60,C62,C64,C66
0124-0001		CAPACITOR TANF 1 UF 25V 20% C90
0124-1126		CAPACITOR TANT AXIAL 10 uf 25V +-10% C1, C5, C14, C21, C23, C54, C65, C67, C83
0140-0003		INDUCTOR, 3.3 uh 3A AXIAL LEAD L3, L4
0150-0495		JUMPER 22 AWG .600 SAMTED JL-600-25-T L1,L2
0150-0617		CONNECTOR 4 PIN J44
0150-0619		HEADER, PCB- PIN 9 POS. J40,J43
0150-0671		HEADER 10 PIN RIBBON STRAIGHT .090 BD. J41
0150-0676		CONNECTOR, 34 PIN STRAIGHT .090 BD. J42
0150-0691		POLARIZING KEY J43,J44,J45
0150-1100		CONNECTOR J46
0150-1544		CONNECTOR FS1,FS2

CRT PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0150-1581		SOCKET/GARRY U3
0150-1582		SOCKET/GARRY U2
0165-0122		HEATSINK TO-220 VERT W/TAB .25 AAVID Q1, Q2, Q3, Q4, REG1
0180-0051		SVP 90V 2KVA SG1,SG2,SG3
0200-0001		TRANSISTOR 2N3904 Q7
0200-0007		TRANSISTOR 2N6430 Q5
0200-0055		TRANSISTOR Q2,Q4
0202-0001		TRANSISTOR 2N3906 Q6
0202-0055		TRANSISTOR Q1,Q3
0206-0053		DIODE 1N5819 CR7,CR8,CR9,CR10
0206-0079		DIODE, SB140 SCHOTTKY F-126 PKG. CR5,CR6
0206-0108		DIODE ZENER 1N5232B 5.6V CR1
0206-0167		DIODE ZENER 1N4745A 16V CR2,CR11,CR12
0209-0060		OSCILLATOR, 12 MHZ OSCILLATOR MODULE OSC1
0210-0007		OPAMP, TL072BCP U6
0210-0014		OP37GP U5,U8
0210-0020		I.C. LINEAR U13,U14
0210-0101		VOLTAGE REFERENCE LM 385BZ-2.5 U9
0210-0117		REGULATOR LM330T-5.0 REG1
0210-0136		ANALOG SWITCH DG243CJ U7
0212-0103		IC 8KX8 RAM 100ns U4
1002-0502		PROGRAMMED EPROM- CRT CHARACTER SET U3
0212-0131		IC 74HCT244 U1
0212-0198		HEX BUFFER N CHANNEL U12

CRT PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
1002-0500		PROGRAMMED 87C51 MICROCOMPUTER- CRT U2
0212-0301		74ALS161 SYNC 4-BIT BINARY COUNTER U10
9212-0001		CRT CONTROL ZMI 9212 U11
9300-0035	B	CRT/CONTROLLER PCB
0150-0493		JUMPER 22awg .400 SAMTEC JL-400-25-T
0100-1212		RESISTOR 12K1 1/4W CMF R45
0108-0026		TRIMPOT 50K OHM SINGLE TURN 3/8"SQ TO-S R53
0120-0011		CAP CERAMIC 68pf 50V AXIAL C72
0124-0066		CAPACITOR 220uf 25V SPRAGUE C166, C167
0206-0110		DIODE ZENER 1N5234 CR3
0212-0132		IC 74HCT245 U25
0163-0151		SCREW 4-40X1/4 PAN PH SS USED A Q1, Q2, Q3, Q4, REG1
0163-0036		WASHER, INTERNAL STAR #4 SS Q1, Q2, Q3,Q4, , REG1
0163-0006		NUT 4-40 UNC SS Q1, Q2, Q3, Q4, , REG1
0550-0010		THERMAL COMPOUND Q1, Q2, Q3, Q4, REG 1
0122-0003		CAPACITOR FILM 100NF C100
0206-0001		DIODE 1N4148 CR13
0100-147R		RESISTOR 147 1/4W CMF R8

DEFIBRILLATOR ASSEMBLY

Part Number	Rev	Description
0208-0020		OPTO-COUPLER HCPL2731 U3,U4,U5
0210-0109		COMPARATOR QUAD LM339 U6
0210-0052		DUAL OPAMP W/DUAL COMPARATOR MC3405 U2
0200-0001		TRANSISTOR 2N3904 Q1,Q3,Q4
0204-0101		MOSFET IRF540 Q6,Q7
0204-0128		MOSFET IRF723 Q5
0210-0126		PW MODULATOR SG3524B U1
0206-0001		DIODE 1N4148 CR1, CR2, CR4, CR5, CR6, , CR11, CR12, CR13, CR17, CR21, CR22
0206-0054		DIODE 1N4004 CR14, CR24, CR15, CR25, CR8
0206-0055		DIODE SCHOTTKY 1N5711 CR7
0206-0183		DIODE ZENER 1N4761 75V CR18
0206-0167		DIODE ZENER 1N4745A 16V CR16
0206-0108		DIODE ZENER 1N5232B 5.6V CR3,CR10
0175-0010		RELAY OMRON G6B-1114P-USDC12 K1
9141-0015	C	TRANSFORMER, FLYBACK DEFIB.
0124-0197		CAPACITOR, 1400 uF /25V C9
0124-0070		CAPACITOR AL ELEC 470UF 35V C8
0124-0007		CAPACITOR TANT 3.3 uf 25 v 10% C2, C18
0124-0046		CAPACITOR TANTALUM .68UF 10V C4
0120-0149		CAPACITOR CERAMIC .1 uf 10% C11, C13,C20, C10, C15, C16, C17
0120-0019	A	CAPACITOR CERAMIC 330PF 5KV C1
0120-0045		CAPACITOR CERAMIC 47NF 50V + - 20% C7
0120-0041		CAPACITOR CERAMIC 22 nf 50V 10% C3
0100-1001		RESISTOR 1K00 1/4W CMF R22, R29, R33, R42, R51
0100-1002		RESISTOR 10K0 1/4W CMF R5, R8, R9, R19, R21, R25, R27

DEFIBRILLATOR ASSEMBLY, continued

Part Number	Rev	Description
0100-1003		RESISTOR 100K 1/4W CMF R17
0100-1004		RESISTOR 1 MEG 1% R39
0100-4642		RESISTOR 46K4 1/4W CMF R28
0100-2151		RESISTOR 2K15 1/4W CMF R31, R32, R37, R38, R46, R49
0100-8251		RESISTOR 8K25 1/4W CMF R3
0100-4223		RESISTOR 422k OHM 1/4W R34
0100-4641		RESISTOR 4K64 1/4W CMF R13,R15,R16,R47
0100-4643		RESISTOR 464K 1/4W CMF R26
0100-1962		RESISTOR 19.6K RN55D R14
0106-0004		RESISTOR LVR-3 .01 3W R50
0106-0005		RESISTOR DUMP 47K 10W 3% R1
0150-0654		CONNECTOR J80
0180-0074		FUSEHOLDER ITEM3
9330-0025	A	HEATSINK, DEFIB, Q7
9300-0033	B	PCB DEFIB
0175-0016	A	RELAY KILOVAC K81B245 K2
0106-0011		RESISTOR 100 OHM 1/2W 5or10% CARBON COMP R2
0180-0027		FUSE, SLO-BLO 15A 32V
0124-0003		CAPACITOR 1.5uF/25V TANTALUM C19
0102-511R		RESISTOR, 511 OHM 1/2 W 1% R23
0100-162R		RESISTOR, 162 OHM RN55D R57
0100-31R6		RESISTOR 31.6 1/4W CMF R24
0150-1544		CONNECTOR J84, J85, J86
0150-0251		2 POS PINHEADER STRAIGHT ANGLE J81

DEFIBRILLATOR ASSEMBLY, continued

Part Number	Rev	Description
0150-0615		CONNECTOR J82
0150-0151		3 POS RA HEADER J83 AMP 3-102203-4
0150-0465		TURRET TURRET 1,2,3,4
0150-0485		TEST POINTS [SOLD IN STRIPS] TP1- T16
0150-0491		SAMTEC JL-250-25-T TMP1 TMP2
0100-6191		RESISTOR 6.19K RN55D R56
0100-68R1		RESISTOR, 68.1 OHM RN55D R43
0100-3481		RESISTOR 3.48K RN55D 1% R55
0100-3831		RESISTOR 3.83K RN55D 1% R11
0163-0153		SCRW, MACHINE S/S 4/40 X 3/8 Q5, Q6
0100-2152		RESISTOR 21K5 1/4W CMF R18
0100-681R		RESISTOR 681 1/4W CMF R58
0100-2611		RESISTOR 2K61 1/4W CMF R30, R36, R35, R48
0100-1622		RESISTOR 16.2K RN55D R7
0160-0046		WASHER, INSULATING SHOULDER
0163-0036		WASHER, INTERNAL STAR #4 SS Q5, Q6
0163-0016		WASHER, FLAT # 4 Q5, Q6
0163-0006		NUT 4-40 UNC SS
9330-0019	A	INSULATOR, DEFIB HEATSINK
0165-0025		INSULATOR, THERMALFILM Q5, Q6
0163-0151		SCREW 4-40X1/4 PAN PH SS Q7
0550-0010		THERMAL COMPOUND
0122-0141		CAPACITOR .10 mFd 10% 63V C5, C6, C14
0100-1152		RESISTOR 11.5K 1/4W CMF R4
0100-2372		RESISTOR 23.7K RN55D R12

DEFIBRILLATOR ASSEMBLY, continued

Part Number	Rev	Description
9330-0047	A	INSULATOR, DEFIB DUMP RESISTOR R1
0163-0045		6-32 LOCKNUT NYLON INSERT HEATSINK
0163-0179		SCREW 6-32X7/16 PAN PH SS HEATSINK
0150-0691		POLARIZING KEY J80

ECG PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
9300-0042	A	PCB ECG
9320-0041	A	SHIELD ECG BASE
9320-0040	B	SHIELD ECG, COVER REV B
1002-0041	A	ASSEMBLY, RELAY PROTECT NO K1
0175-0025		RELAY AROMAT#DS4E-SL2-DC12V K2, K3
0208-0006		SUPPRESSOR NEON CC7 SG2, SG3, SG4
9141-0005	B	TRANSFORMER ISOLATION T1
0180-0131		VARISTOR METAL OXIDE GE#V430MA3A M1, M2
0204-0005		FIELD EFFECT TRANSISTOR Q6
0210-0110		DUEL OPAMP LF442CN U1
0210-0003		OPAMP TL071 U2,U3,U9,U13,U15
0210-0007		OPAMP, TL072BCP U4, U10, U11, U6
0210-0120		IC LM709 U7
0210-0125		POWER MOSFET VQ1000J SILICONIX U8
0206-0112		DIODE ZENER IN5236B 7.5V .5W CR1, CR2
0206-0001		DIODE 1N4148 CR3,CR4,CR5,CR6,CR9,CR10,CR11,CR12, CR17,CR18,CR19 CR20,CR21,CR22,CR25, CR28,CR31,CR32,CR33,CR34
0206-0065		DIODE FAIRCHILD#FDH300 CR7 CR13 CR15 CR16
0206-0209		DIODE BAV20 CR8 CR14
0206-0015		DIODE ZENER 1N825A 6.2V CR23 CR24 CR26 CR27
0100-1333		RESISTOR 133k OHM 1/4W R9
0100-6192		RESISTOR 61.9K 1/4W CMF R1, R2, R3, R5, R6, R7, R78
0100-3164		RESISTOR 3.16 MEG RN55D R4, R8
0100-1474		RESISTOR 1M47 1/4W CMF R10,R23,R30,R40
0100-1003		RESISTOR 100K 1/4W CMF R11,R12,R15,R17,R24,R27,R31A,R34,R79

ECG PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0100-6812		RESISTOR 68K1 1/4W CMF R14, R39, R54
0100-3162		RESISTOR 31K6 1/4W CMF R16
0100-2873		RESISTOR 287K RN55D R18, R28
0100-2372		RESISTOR 23.7K RN55D R19,R29,R35,R81,R82,R93,R94
0100-4221		RESISTOR 4.22K RN55D R21
0100-1781		RESISTOR 1.78K RN55D 1% R67, R84
0100-4641		RESISTOR 4K64 1/4W CMF R25,R50
0100-3831		RESISTOR 3.83K RN55D 1% R26, R38, R70
0100-1471		RESISTOR 1K47 1/4W CMF R31
0100-1002		RESISTOR 10K0 1/4W CMF R37, R92, R59, R110
0100-1004		RESISTOR 1 MEG 1% R32
0100-1001		RESISTOR 1K00 1/4W CMF R33,R36,R46,R53
0100-7501		RESISTOR 7k5 OHM 1/4W R44
0100-2153		RESISTOR 215K 1/4W CMF R65,R66
0100-100R		RESISTOR 100 1/4W CMF R51,R200
0100-1622		RESISTOR 16.2K RN55D R89
0108-0108		POT, 5K OHM R52
0108-0113		TRIMPOT 100K OHM R47, R55, R76
0100-825R		RESISTOR 825 1/4W CMF R73
0100-215R		RESISTOR 215 1/4W CMF R71 R86
0110-0475		RESISTOR 14 DIP RP1
0122-0001		CAPACITOR FILM 1NF C1,C3,C10,C57
0122-0003		CAPACITOR FILM 100NF C7, C8, C22, C24, C27, C29, C31, C32, C40, C55, C61

ECG PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0120-0137		CAPACITOR CERAMIC .01uF C12,C44,C46,C20
0122-0097		CAPACITOR FILM 1uF C13,C36
0122-0094		CAPACITOR FILM .33uF C14
0120-0009		CAPACITOR CERAMIC 47 PF 50V C4, C16 CENTRALAB C40C470J
0122-0095		CAPACITOR FILM .47uF C17, C35
0122-0093		CAPACITOR FILM .22uF C28 C37 C38
0122-0286		CAPACITOR 47nf 5% 100v C34 C33
0120-0013		CAPACITOR CERAMIC 100PF C30
0122-0149		CAPACITOR FILM AXIAL 3.3 nf 63V 10% C5, C6
0120-0071		CAPACITOR CERAMIC DISC .01 UF DC-103 C42
0100-300R		RESISTOR 300 OHM RN55D R49
0100-1212		RESISTOR 12K1 1/4W CMF R88
0100-1472		RESISTOR 14K7 1/4W CMF R72
0100-2492		RESISTOR 24k9 OHM 1/4W R90
0100-2003		RESISTOR 200k OHM 1/4W R80
0100-3162		RESISTOR 31K6 1/4W CMF R57
0100-196R		RESISTOR, 196 OHM RN55D R75
0100-3832		RESISTOR 38K3 1/4W CMF R91
0100-4992		RESISTOR 49k9 OHM 1/4W R41, R69, R77, R74
0100-26R1		RESISTOR, 26.1 OHM R22
0110-0043		RESISTOR, 47 SIP S1
0110-0021		RESISTOR 1K SIP S2
0208-0042		OPTO ISOLATOR ISO 1-8

ECG PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0204-0248		FET 2N 7000 Q2,Q3,Q4,Q5,Q8
0200-0040		TRANSISTOR NPN Q1
0206-0053		DIODE 1N5819 CR30
0210-0137		DG418DJ ANALOG SWITCH U5
0210-0128		MULTIPLEXER DG508ACJ U14
0120-0015		CAPACITOR CERAMIC 150 PF C25
0120-0021		CAPACITOR CERAMIC 470 PF C15
0120-0017		CAPACITOR CERAMIC 220PF C26
0104-9091		RESISTOR 9.09K RN55D .1% R64
0104-3832		RESISTOR 38.3K RN55D .1% R63
0210-0122		VOLTAGE REGULATOR LM 337LZ U12
0100-1242		RESISTOR 12.4K RN55D 1% R60
0100-3481		RESISTOR 3.48K RN55D 1% R43
0104-6812		RESISTOR 68.1K RN55D .1% R61 R62
0100-3163		RESISTOR 316K RN55D R48
0104-2672		RESISTOR, 26.7K RN55D .1% R58
0100-46R4		RESISTOR, 46.4 OHM RN55D R68
0108-0110		TRIMPOT 20K OHM R85
0100-249R		RESISTOR 249 OHM 1% R83
0122-0002		CAPACITOR FILM 10NF C21
0120-0270		CAPACITOR PHILLIPS 82 pf 500V 2% C2, C9
0122-0172		CAPACITOR FILM 2.2 NF 630V 10% C58
0124-0056		CAPACITOR 33 uf/35V TANALUM 10% C43
0150-0666		HEADER 34 PIN RIGHT ANGLE P1

ECG PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0150-0153		5 PIN S. CONNECTOR P6,P11
0150-0154		6 PIN CONNECTOR P10
0124-0001		CAPACITOR TANF 1 UF 25V 20% C53
0100-8252		RESISTOR 82K5 1/4W CMF R87
0163-0036		WASHER, INTERNAL STAR #4 SS
0163-0006		NUT 4-40 UNC SS
0100-1213		RESISTOR 121K 1/4W CMF R56
0100-3924		RESISTOR CMF-55 3.92 MEG 1% R13
9330-0037		INSULATOR, ECG SHIELD COVER
0163-0326		SCREW,6-32 X 1/4 PAN SLOTTED NYLON
0163-0355		SCREW 8-32 X 1/2 PAN SLOTTED NYLON
0150-0237		HEADER, 3 POS UNSHROUDED .025 DIA. TP4, TP5, TP6
0163-0371		HEX NUT #6 NYLON
0124-0037		CAPACITOR TANT 10uF 35v 10% .100 LEAD SP C11, C18, C19, C45, C47, C48, C54, C56
0122-0288		CAPACITOR, FILM .1uf 100V 5% POLYESTER C49, C50, C51, C52
0100-1784		RESISTOR 1M78 1/4W CMF R31B
0120-0335		CAPACITOR 1uF 50V CK06 C21A
0204-0008		VP2410L MOSFET P-CHANNEL Q7
0100-511R		RESISTOR 511 OHM 1/4W R42
0124-1126		CAPACITOR TANT AXIAL 10 uf 25V +-10% C39
0100-2871		RESISTOR 2.87K RN55D R20

INPUT/OUTPUT PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
9500-0024		ASSY, CABLE-RIBBON MAINCTRL TO I/O PCB J2
0150-0440		CONNECTOR 15 PIN SUB MINI J1
9300-0025	B	INPUT/OUTPUT PCB
0100-511R		RESISTOR 511 OHM 1/4W R1,R2,R3,R4,R7,R8,R9,R10,R11,R12,R5,R6
0120-0456		CAP CERAMIC .047uF 200V 20% X7R RAD DIP C3,C4,C5
0120-0702		CAP CERAMIC .47uf 100V 20% X7R RAD DIP C2
0150-0188		HEADER 40 POS J3
0120-0121		CAPACITOR CERAMIC 470pF C1,C6

PACER MODULE ASSEMBLY

Part Number	Rev	Description
9300-0040	4	PACER PCB
0150-0652		CONNECTOR HEADER 14 PIN RA P3
9500-0047	A	ASS'Y CABLE-POWER PWR SUP TO PACER
0150-0164		16 POS RA HEADER P2
0106-0020		RESISTOR 330 OHM 2W 5 OR 10% CARBON COMP R28,R29,R32,R33
0106-0003		RESISTOR 0.1 OHM 2W R1
0101-1003		RESISTOR 100K 5% CARBON FILM R2, R3
0100-1001		RESISTOR 1K00 1/4W CMF R4, R5, R6, R7, R16
0100-1002		RESISTOR 10K0 1/4W CMF R13,R15,R34
0100-1212		RESISTOR 12K1 1/4W CMF R19
0100-316R		RESISTOR 316 1/4W CMF R20
0100-249R		RESISTOR 249 OHM 1% R23, R30
0100-750R		RESISTOR, 750 OHM RN55D R24
0100-1004		RESISTOR 1 MEG 1% R21, R22, R26 R27
0102-1002		RESISTOR 10K 1W RN 65D***** R25
0122-0007		CAPACITOR FILM .1UF 400V 5% C13
0122-0003		CAPACITOR FILM 100NF C6, C7
0124-0013		CAPACITOR TANT 10UF 25V C10,C12,C14,C15
0120-0111		CAP C4, C5
0124-0031		CAPACITOR 330uF 6.3V TANTALUM C11
0206-0121		DIODE ZENER 1N5245B 15V CR1, CR2
0206-0001		DIODE 1N4148 CR3,CR4,CR18
0206-0045		DIODE ZENER 1N5383B CR5, CR6
0206-0051		DIODE RECTIFIER 1N4937 CR7, CR8, CR9, CR10
0180-0050		SVP 350V 5KVA SG 1

PACER MODULE ASSEMBLY, continued

Part Number	Rev	Description
0180-0052		SVP 630V 5KVA SG2,SG3,SG4
0208-0042		OPTO ISOLATOR U5
9141-0006	C	OUTPUT TRANSFORMER T1
0200-0001		TRANSISTOR 2N3904 Q3, Q4, Q5
0204-0001		POWER MOSFET RFM 15 N12 Q1, Q2
0165-0101		HEATSINK TO-3 W/ MOUNTING .50 HT Q1, Q2
0212-0053		IC CD4053BE U3
0210-0031		OPAMP CA3160AE U1, U2
0210-0122		VOLTAGE REGULATOR LM 337LZ U4
0180-0074		FUSEHOLDER F1
0501-0001		CABLE TIE
0180-0045		FUSE, 3AG 3ASB
0150-1544		CONNECTOR P4
0206-0078		RECTIFIER HI VOLTAGE 5K 3A CR14,CR15
9330-0044		INSULATOR SHIELD, PACER ASS'Y
0163-0178		SCREW #6-32x3/8" UNC-2B PAN PH SS Q1, Q2
0163-0027		WASHER EXT STAR #6 SS Q1, Q2
0550-0010		THERMAL COMPOUND Q1, Q2
0163-0328		6-32X3/8 PAN SLOTTED NYLON
0160-0007		STANDOFF 1/4" X 11/16" NYLON # 6-32
0106-0015		RESISTOR 180 OHM 1W 5or10% CARBON COMP R31
0122-0002		CAPACITOR FILM 10NF C1, C2
0100-1822		RESISTOR 18.2 K RN 55D R17
0100-1781		RESISTOR 1.78K RN55D 1% R8
0204-0258		MOSFET, BS 107 N CHANNEL Q6
0175-0026		RELAY 12 VDC 8A AROMAT ST2E-DC12V RY1

POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
9300-0039	A	PCB, POWER SUPPLY
0204-0006		TRANSISTOR FET RFP12P08 Q4, Q5, Q6
0210-0301		REGULATOR LAS6321 U5
0210-0055		MC34063P1 DC to DC CONVERTER CONTROL U4
0175-0010		RELAY OMRON G6B-1114P-USDC12 K1, K2
0120-0149		CAPACITOR CERAMIC .1 uf 10% C18,C24,C11
0120-0133		CAPACITOR .0047uF CERAMIC C26
0120-0137		CAPACITOR CERAMIC .01uF C32,C2
0120-0327		CAPACITOR .22uF CERAMIC C23,C27
0124-0003		CAPACITOR 1.5uF/25V TANTALUM C 28/ .1" CENTER. [.2 BOARD]
0120-0145		CAPACITOR .047uF CERAMIC C29,C30
0120-0331		CAPACITOR .47uF CERAMIC C25
0100-2002		RESISTOR 20k OHM 1/4W R3
0100-1002		RESISTOR 10K0 1/4W CMF R13, R15, R19, R32
0100-2151		RESISTOR 2K15 1/4W CMF R14
0100-9091		RESISTOR, 9.09K RN55D R16
0100-8251		RESISTOR 8K25 1/4W CMF R30
0100-1001		RESISTOR 1K00 1/4W CMF R9, R12, R21, R17
0124-0274		CAPACITOR 1000UF/25V C33, C35
0206-0094		DIODE, 1N 4936 CR2, CR3
0204-0248		FET 2N 7000 Q1, Q2, Q3,
0108-0110		TRIMPOT 20K OHM R1
0210-0123		REGULATOR U1
0140-0408	B	INDUCTOR L6, L7, L2

POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0124-0731		CAPACITOR, 470uf/35V C16, C17, C21, C22
0124-0017		CAPACITOR, TANF 22 uf , 16V C1
0100-560R		RESISTOR 560 OHM 1/4W R20
0100-1333		RESISTOR 133k OHM 1/4W R2
0150-0675		HEADER, 26 PIN STR. RIBBON P10 3M 3593-6002
0150-0619		HEADER, PCB- PIN 9 POS. P8
0150-0251		2 POS PINHEADER STRAIGHT ANGLE P4, P3
0150-1544		CONNECTOR P6, P7, P9
0150-0052		HEADER, SHROUDED 4 POS. STR. P11
0150-1605		HEADER 7POS RA .100 CL .025 S9 POSTS P12
0120-0335		CAPACITOR 1uF 50V CK06 C14, C19, C36, C38
0210-0053		IC MC 34060P U6
0206-0087		DIODE MUR 405 CR6, CR4
0200-0055		TRANSISTOR Q7
0108-0108		POT, 5K OHM R36
0106-0003		RESISTOR 0.1 OHM 2W R34
0100-5111		RESISTOR 5k11 1/4W CMF R23, R31
0100-4751		RESISTOR 4K75 OHM 1/4W R24
0100-2212		RESISTOR 22k1 OHM 1/4W R25, R27
0100-47R5		RESISTOR 47.5 OHM RN55D 1% R28, R35
0106-0015		RESISTOR 180 OHM 1W 5or10% CARBON COMP R29
0120-0125		CAPACITOR CERAMIC 1000pF C31
0100-422R		RESISTOR, 422 OHM RN55D R33

POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY, continued

Part Number	Rev	Description
0100-4222		RESISTOR 42K2 1/4W CMF R10, R11
0108-0106		POT , 1K OHM R22, R40
0206-0307		1N5340B 6V 5W DIODE, ZENER CR5
0206-0318		1N5351 B 14V 5W DIODE ZENER CR7
0165-0050		HEATSINK, 8 PIN DIP U1, U4
0165-0051		HEATSINK 14 PIN DIP CLIP-ON U5
0500-0272		WIRE 20 AWG. RED 2" LG
0500-0273		WIRE, 20 AWG. ORANGE 2" LG
0150-1521		TERMINAL, .250 FASTON FLAG FEM 22-18 awg
0501-0001		CABLE TIE
9500-0037	B	ASS'Y CABLE, PWR SUPP TO DEF1B PARTS LIS NEXT ASS'Y PL 9301-0022
0550-0010		THERMAL COMPOUND
0206-0001		DIODE 1N4148 CR8, CR9, CR1
0124-0013		CAPACITOR TANT 10UF 25V C37
0501-0016		MINIBASE T&B 4-WAY
9330-0043		INSULATOR, L7-PWR SUPPLY PCB L2
0120-0121		CAPACITOR CERAMIC 470pF C15
0206-0064		DIODE 1N5822 CR10
0101-0R33		RESISTOR .33 OHM 1/4W 5% R37
0100-1211		RESISTOR 1K21 RN55D R41
0100-3161		RESISTOR 3K16 1/4W CMF R39
0165-0128		HEATSINK TO-220 W/ TAB VERT AAV1D 5943B USE ON Q6

POWER SUPPLY CONTROL PRINTED CIRCUIT BOARD ASSEMBLY

Part Number	Rev	Description
0210-0054		TL431CLP PROGRAMMABLE PREC. REFERENCES U1, U2
0202-0001		TRANSISTOR 2N3906 Q1, Q2
0204-0248		FET 2N 7000 Q3, Q4
0206-0001		DIODE 1N4148 D1, D3, D6
0206-0108		DIODE ZENER 1N5232B 5.6V D4
0124-0009		CAPACITOR 4.7uf/35V TANTALUM C1
0124-0013		CAPACITOR TANT 10UF 25V C6
0124-0054		CAPACITOR 22uF 50V C5, C10
0124-0003		CAPACITOR 1.5uF/25V TANTALUM C12, C4, ^C18
0124-0058		CAPACITOR 47uF/35V TANTALUM C11
0124-0056		CAPACITOR 33 uf/35V TANALUM 10% C9,C14
0120-0025		CAPACITOR CERAMIC 1NF C2
0120-0149		CAPACITOR CERAMIC .1 uf 10% C3, C7, C8
0108-0109		BOURNS POT R4
0100-2001		RESISTOR 2k0 OHM 1/4W R6, R14
0100-4223		RESISTOR 422k OHM 1/4W R2
0100-1001		RESISTOR 1K00 1/4W CMF R1
0100-5112		RESISTOR 51k1 OHM 1/4W R3
0100-3163		RESISTOR 316K RN55D R7
0100-5112		RESISTOR 51k1 OHM 1/4W R10, R12
0100-1002		RESISTOR 10K0 1/4W CMF R17, R8
9300-0028	A	POWER SUPPLY CONTROL BD. NEW SQ. BDBD
0150-1655		RECEPT ASSY 7 POS TOP ENTRY.100 CL P1
0100-215R		RESISTOR 215 1/4W CMF R5, R13

POWER SUPPLY CONTROL PRINTED CIRCUIT BOARD ASSEMBLY, *continued*

Part Number	Rev	Description
0210-0101		VOLTAGE REFERENCE LM 385BZ-2.5 D7
0100-2002		RESISTOR 20k OHM 1/4W R22
0100-4222		RESISTOR 42K2 1/4W CMF R15
0500-0109		WIRE BUS 24 AWG R21, D8 1" LG
0206-0101		DIODE, 1N5225B D2
0100-249R		RESISTOR 249 OHM 1% R20
0100-6193		RERSISTOR 619K RN55D R11
0100-2153		RESISTOR 215K 1/4W CMF R19